(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

Ref No: SMVDU/SoCSE/2025/~~EB~~ 190

Date: 18.7.2025

Minutes of the 18th Meeting of the Board of Studies (BoS)

The 18th Meeting of the Board of Studies (BoS) of the School of Computer Science & Engineering (SoCSE), Shri Mata Vaishno Devi University (SMVDU), was held on 16th July 2025 at 2:00 PM in online mode.

The details of the online meeting are as follows:
Mode: Online (via Google Meet)
Venue: School of Computer Science & Engineering (SoCSE)
Google Meet Link:- https://meet.google.com/rhb-rger-anv
Date: 16th July 2024
Time: **2:00 pm**

The following members attended the meeting:

1. Prof. Vijay Laxmi, Dept. of Computer Science and Engineering, MNIT Jaipur, External Member
2. Dr. Sunanda, Chairman & Head, SoCSE
3. Mr. Manoj Kumar Verma, Associate Head, SoCSE
4. Prof. (Dr.) Manoj Kumar Gupta
5. Prof. (Dr.) Ajay Kaul
6. Dr. Baijnath Kaushik
7. Dr. Pooja Sharma
8. Dr. Sakshi Arora
9. Dr. Naveen Kumar Gondhi
10. Dr Rohit Tanwar
11. Dr. Archana Purwar
12. Dr. Sonika Gupta
13. Mr. Sanjay Kumar Sharma
14. Dr. Deo Prakash
15. Mr. Sudesh Kumar
16. Dr. Vipal Kumar Sharma
17. Dr. Ravi Datta Sharma (Coordinator M.Sc. Data Science Program)

The agenda items were placed before the members of the Board of Studies and the following discussions/recommendations were made:

- **Agenda Item No. 1: To Review and Approve the Course Structure for M.Sc. in Data Science (w.e.f. Entry Batch 2025)**

The proposed course structure for the M.Sc. programme in Data Science was placed before the Board for consideration and discussion.

The Board members thoroughly reviewed the structure and after deliberation, approved the course structure with the following modifications:

1. The course titled "Statistics and Exploratory Data Analysis" in the first semester was proposed to be renamed as **"Statistics and Probability for Analytics"** – the proposal was reviewed and approved.
2. The elective course "Database Technologies" was proposed to be merged with the existing course "Introduction to Linux". The revised course is now titled **"Introduction to Linux and Database Technologies"**, to be offered in the first semester.
3. The elective course **"Data Visualization"** in the second semester was proposed to be included as a core in place of the course "Time Series". The course on "Time Series" has been added to the bucket list of electives.
4. A new elective course titled **"Emerging Technologies in AI"** was proposed to be added in the fourth semester. The proposal was reviewed and approved by the Board.

The revised and approved course structure is attached as **Annexure 'A'** for reference.

- **Agenda Item No. 2: To consider and approve the Course Codes for M.Tech (Artificial Intelligence) Courses**

The proposed course codes for all courses under the **M.Tech (Artificial Intelligence)** programme were placed before the members of the Board of Studies for consideration. The Board reviewed the course codes in accordance with the existing Academic Regulations and the specific programme requirements.

The list of course codes assigned is attached herewith as **Annexure 'B'** for reference and record.

After due deliberation, the Board approved the course codes and corresponding course structure as presented.

- **Agenda Item No. 3: To consider and approve Program Specific Outcomes (PSOs) for B.Tech and M.Tech Program**

The Program Specific Outcomes (PSOs) for the B.Tech and M.Tech programs, as vetted and recommended by the Academic Affairs Committee (AAC), were placed before the Board of

Studies for consideration and approval. The vetted PSOs are enclosed as **Annexure 'C'** for reference.

The committee was requested to deliberate on the proposed PSOs in the context of the respective programme objectives, curriculum alignment, and industry relevance.

After due deliberations, the Board approved the Program Specific Outcomes (PSOs) as presented for both the B.Tech and M.Tech programs.

Agenda Item No. 4: Action Taken on the Request of Mr. Abhas Kumar (Entry No. 14BCSO01) for Permission to Complete B.Tech. Degree.

Reference:

a. Agenda Item No. 37.17 of the 37th Meeting of the Academic Council, SMVDU
b. Ref No. SMVDU/AA/25/366 dated 05/06/2025

The case of Mr. Abhas Kumar (Entry No. 14BCSO01), a former student of the B.Tech. (CSE) programme, was placed before the Board members for information, in reference to the above-mentioned communications.

The matter pertained to Mr. Abhas Kumar's request seeking permission to appear in backlog examinations and pursue the 8th semester in order to complete the degree. However, the Academic Council, in its 37th Meeting, did not approve the request, citing previous decisions and the student's academic record.

Subsequently, as per IoC Ref. No. SMVDU/AA/25/366 dated 05/06/2025, the student has been duly informed, and an Action Taken Report has been forwarded to the Academic Affairs Wing via Ref. No. SMVDU/SoCSE/25/181 dated 11th July 2025.

The matter was placed before the BoS members for information.

The Board approved the action taken in the matter. The agenda item stands closed.

Agenda Item No. 5: Action Taken with Respect to Agenda Item No. 37.43(E) of the 37th Meeting of the Academic Council of SMVDU

Reference:

a. Agenda Item No. 37.43(E) of the 37th Meeting of the Academic Council, SMVDU
b. IOC Ref. No.: SMVDU/AA /25/370 dated 05/06/2025

The Board was apprised of the directive issued under Agenda Item No. 37.43(E) during the 37th Meeting of the Academic Council of SMVDU, wherein it was desired that the new course codes proposed by the School of Computer Science & Engineering be considered provisionally

approved, subject to final vetting and incorporation of any required amendments by the Examination Wing.

In compliance with the above directive, the matter was placed before the members of the BoS for review and confirmation of the proposed changes to the course codes, ensuring alignment with the academic regulations and course structuring norms.

Following detailed deliberations, the final course codes were reviewed, approved, and have been incorporated into the B.Tech course structures for the Entry Batches 2023 and 2024.

The Board approved the final course codes.

Agenda Item No. 6: To consider and approve the course structure and syllabus of the subject – Introduction to Artificial Intelligence as a Minor Course

The syllabus for the newly proposed minor course titled *Introduction to Artificial Intelligence* was presented before the Board of Studies for deliberation and approval. The course is intended to provide foundational knowledge in Artificial Intelligence (AI) as part of the Minor specialization.

The detailed syllabus outlining the course objectives, unit-wise content distribution, and recommended readings is enclosed as **Annexure 'D'** for reference.

After review and discussion, the Board approved the proposed syllabus.

Agenda Item No. 7: To consider and approve the revised syllabus for the Courses: *Data Science and Analytics* & *Data Science and Analytics Lab* offered under 3rd semester of B.Tech programme

The revised syllabi for the theory course *Data Science and Analytics* and its corresponding *Lab* component were presented before the Board for review and approval.

Both the existing and proposed versions of the syllabi were submitted and are attached as **Annexure 'E'** for reference.

The Board approved the syllabi for *Data Science and Analytics* and *Data Science and Analytics Lab* as proposed.

Agenda Item No. 8 : To consider and approve the revised syllabus for the Course: *High Performance Computing* offered as an elective course under B.Tech programme

The revised syllabus for the elective course *High Performance Computing (HPC)*, offered under the B.Tech programme, was placed before the Board for review and approval. The proposed updates were discussed in detail during the meeting.

Both the existing and proposed versions of the syllabus were shared with the members and are attached as **Annexure 'F'** for reference.

After thorough deliberation, the Board reviewed and approved the updated syllabus for the *High Performance Computing* course.

Agenda Item No. 9: Introduction of Elective Course – *Research Project* for B.Tech Students (Entry Batch 2024 onwards)

As per the mandate of the 37th Academic Council Meeting, the School of Computer Science & Engineering (SoCSE) proposed the introduction of a new elective course titled *Research Project* under the category of School Electives / Discipline Elective Courses (DEC). The course aims to promote a research-oriented mindset among undergraduate students and encourage early academic and scientific contributions.

This course is proposed to be incorporated into the B.Tech curriculum structure from the entry batch of 2024 onwards, to be offered in the fifth semester as School Elective II.

The detailed guidelines for the course, as prescribed in the new academic framework, were presented and are enclosed as **Annexure 'G'**.

The following key points and clarifications were discussed and agreed upon during the meeting:

1. Registration for the course shall begin in the 5th semester, with the provision that interested students shall receive adequate guidance and mentorship from faculty members before registration
2. If a student is unable to meet the publishing requirement (i.e., in SCI / SCI Expanded / Scopus / ABDC / SSCI / Premier / Commendable Research categories without impact factor) by the end of the 7th semester, the student shall be given the option to switch to another elective course in the 8th semester to ensure timely completion of the B.Tech degree.

The revised B.Tech course structure incorporating this elective, applicable from the Entry Batch 2024, is attached as **Annexure 'H'** for reference.

The Board approved the introduction of the *Research Project* course as an elective in the B.Tech curriculum from the Entry Batch 2024 onwards, along with the guidelines and provisions mentioned above.

Agenda Item No. 10: Inclusion of Course: *Entrepreneurship and Venture Development* in B.Tech Curriculum (Entry Batch 2024 Onwards)

The Board was apprised that, in accordance with the mandate of the 37th Meeting of the Academic Council, the School of Computer Science & Engineering (SoCSE) has proposed the introduction of a new elective course titled ***Entrepreneurship and Venture Development***. This course is to be

offered under the category of School Electives / Discipline Elective Courses (DEC) in the B.Tech curriculum.

As per the resolution passed in the 37th Academic Council meeting, the course is proposed to be incorporated into the B.Tech programme structure from the Entry Batch of 2024 onwards, and offered in the **5th semester as School Elective II.**

The detailed guidelines for the course, as specified in the new academic framework, are enclosed as **Annexure 'G'**, and the revised course structure including this course is attached as **Annexure 'H'** for review

The following key points and clarifications were discussed

- Enrolment of students must be permitted for internship along with the course *Entrepreneurship and Venture Development*, as attendance shall not be a mandatory criterion, in accordance with the Academic Rules and Regulations prescribed for this elective course.
- The expert members recommended that this clarification be explicitly communicated to students well in advance, to facilitate informed decision-making and smooth academic planning.

After due deliberation, the Board approved the inclusion of the course *Entrepreneurship and Venture Development* in the B.Tech curriculum for the Entry Batch 2024 onwards, with the observations and suggestions duly noted and taken into consideration.

Agenda Item No. 11 Analysis of Student Feedback on Curriculum Development and Resultant Revisions in B.Tech Course Structure.

The Board was apprised of the recent initiatives taken by the School of Computer Science & Engineering (SoCSE) in response to student feedback on the B.Tech curriculum. The feedback, compiled and attached as **Annexure 'J'**, was analysed thoroughly and used to inform curriculum enhancement decisions.

Based on this feedback, the following actions have already been initiated:

- The B.Tech curriculum has been updated with relevant modifications to better align with academic standards and evolving industry expectations.
- The School has proposed to introduce Honours Programs and Minor Specializations starting from the 5th semester, applicable from the B.Tech Entry Batch 2023 onwards, in line with the mandate of the 37th Academic Council Meeting.
- The Lecture-Tutorial-Practical (L-T-P) structure of selected elective courses has been revised to improve pedagogical delivery and enhance student learning outcomes.

Specifically, the L-T-P structures of the following courses have been revised based on curriculum feedback and internal evaluation:

- Nature Inspired Algorithm
- Cloud Computing
- Internet of Things (IoT)

The updated syllabi for the above-mentioned courses are attached as **Annexure 'K'** for review. The proposed revised course structures for:

- B.Tech Entry Batch 2023 is attached as **Annexure 'I'**, and
- B.Tech Entry Batch 2024 onwards is attached as **Annexure 'H'**.

The proposed revisions to the curriculum structure, L-T-P components, and course codes were placed before the Board for review and approval.

The Board approved the proposed revisions in the B.Tech curriculum for both Entry Batch 2023 and Entry Batch 2024 onwards, including:

- Modifications based on student feedback.
- Revisions in the L-T-P structures of elective courses.
- Updated course codes and B.Tech course structures.

The meeting concluded with the Chairperson thanking all members, including the external expert, for their valuable inputs.

The meeting ended with a formal vote of thanks.

Dr. Sakshi Arora
Associate Professor &
Member Secretary, BoS

Dr. Sunanda
Associate Professor & Head
(School of Computer Science & Engineering)

Mr. Manoj Kumar Verma
Assistant Professor &
Associate Head,
Member

Prof. (Dr.) Manoj Kumar Gupta
Professor
Member

Prof. (Dr.) Ajay Kaul
Professor
Member

Dr. Baij Nath Kaushik
Associate Professor
Member

Dr. Naveen Kumar Gondhi
Associate Professor
Member

Dr. Pooja Sharma
Associate Professor
Member

Dr. Archana Purwar
Associate Professor
Member

Dr. Rohit Tanwar
Associate Professor
Member

Dr. Sonika Gupta
Assistant Professor
Member

Mr. Sanjay Kumar Sharma
Assistant Professor
Member

Dr. Deo Prakash
Assistant Professor
Member

Mr. Anuj Mahajan
Assistant Professor
Member

Mr. Sudesh Kumar
Assistant Professor
Member

Dr. Vipal Kumar Sharma
Assistant Professor
Member

Dr. Ravi Datta Sharma
Associate Professor
Special Invitee,
Member

Prof. Vijay Laxmi
MNIT Jaipur
External Expert

Copy to:

1. Chairperson
2. Prof., Vijay Laxmi, External Expert
3. Members of the BoS
4. Dr. Ravi Datta Sharma, Associate Professor, School of Biotechnology
5. Record/office File

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering

Faculty of Engineering, SMVDU

Kakryal, Katra 182320

Annexure 'A'

Course Structure of the M.Sc. Data Science Programme

[Entry Batch 2025]

SMVDU PG Structure 2 (Level 6.5) NEP- Coursework with Research

Semester – I

Course Code	Course Name	Type of Course	L-T-P	Credits
DAS MDXXX	Data Structure & Algorithm Design	DSC-6	3-0-0	3
DAS MDXXX	Data Structure & Algorithm Design Lab	DSC-6	0-0-2	1
DAS MDXXX	Statistics and Probability for Analytics	DSC-2	3-0-0	3
DAS MDXXX	Statistics and Probability for Analytics Lab	DSC-2	0-0-2	1
DAS MDXXX	Research Methodology	DSC-3	3-0-0	3
DAS MDXXX	Mathematics Essential	Bridge Course	NC	
DAS MDXXX	Introduction to Linux and Database technologies	CCC	2-0-2	3
DAS MDXXX	Elective	DSE-1	2-0-4	4
DAS MDXXX	Elective	DSE-2	2-0-4	4

Total Credit=22

Semester – I (Bridge Course, 3 Lecture per week, Non-Credit course)
Mathematics Essential is going to be compulsory for students who have no exposure to mathematics in graduation or intermediate.

Semester – I (Electives)
Students can choose any two electives from the list.

1. Programming in R
2. Programming in Python
3. Big Data Tools &Technologies-I

CCC* Common compulsory course

Semester – II

Course Code	Course Name	Type of Course	L-T-P	Credit
DAS MDXXX	Machine Learning	DSC-1	3-0-0	3
DAS MDXXX	Machine Learning Lab	DSC-1	0-0-2	1
DAS MDXXX	Regression Theory & Analysis	DSC-5	3-0-0	3
DAS MDXXX	Regression Theory & Analysis Lab	DSC-5	0-0-2	1
DAS MDXXX	Data Visualization	DSC-8	3-0-0	3

DAS MDXXX	Data Visualization lab	DSC-8	0-0-2	1
DAS MDXXX	Elective	DSE-3	2-0-4	4
DAS MDXXX	Elective	DSE-4	2-0-4	4
				Total Credit=20

Semester – II (Electives)

Students can choose any two electives from the list.

1. Big Data Tools & Technologies-II
2. Time Series
3. Cloud Computing
4. Pattern Recognition

Semester – III

Course Code	Course Name	Type of Course	L-T-P	Credit
DAS MDXXX	Deep Learning & Neural Networks	DSC-4	3-0-0	3
DAS MDXXX	Deep Learning & Neural Networks Lab	DSC-4	0-0-2	1
DAS MDXXX	Generalized & Linear Modeling	DSC-7	3-0-0	3
DAS MDXXX	Generalized & Linear Modeling lab	DSC-7	0-0-2	1
DAS MDXXX	Graph & Social Network Analysis	DSC-9	3-0-0	3
DAS MDXXX	Graph & Social Network Analysis Lab	DSC-9	0-0-2	1
DAS MDXXX	Elective	DSE-6	2-0-4	4
DAS MDXXX	Elective	DSE-6	2-0-4	4
				Total Credit=20

Semester – III (Electives)

Students can choose any two electives from the list.

1. Natural Language Processing
2. Big Data Tools & Technologies-III
3. Customer Behavior Analysis and Fraud detection
4. Blockchain
5. Next Generation Sequencing Data Analysis
6. Emerging technologies in AI

Semester – IV

Course Code	Course Name	Type of Course	L-T-P	Credit
DAS MDXXX	Research Thesis / Project /Patent	Project	0-0-40	20
				Total Credit=20

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

Outcomes expected of Research thesis/project/Patent in the 2nd Year of PG Programmes

Semester – IV (Applicable to Structure 2)
The following outcomes must be achieved by the end of the IV Semester:

i. Research Problem Identification
ii. Review of literature
iii. Research design formulation
iv. Commencement of experimentation, fieldwork, or similar tasks
v. Completion of experimentation/ fieldwork
vi. Submission of dissertation, presentation with Viva Voce
vii. Research output in the form of any one of the following –
- Prototype or product development/ patent
- Publication/Presentation of research work in National/International Conference/conference proceedings
- Publication in a reputed journal such as Scopus-indexed journals or other similar quality journals
- Book or Book Chapter in a publication by a reputed publisher.
- Development of software or Database/Analysis pipeline/ Extensive analysis of Data
- Any other scholastic work as recommended by the School Research Committee and approved by the competent authority.

Summary (Excluding contact hours of Project)

	First Semester	Second Semester	Third Semester	Fourth Semester	Total
Credits	22	20	20	20	82
Contact Hours (L+T+P) Structure 2	28	24	24	-	76

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

Syllabus - First Semester

DATA STRUCTURE & ALGORITHM DESIGN

Credit Units: 3-0-1:

Course contents:

Unit I: Introduction and Programming strategies Introduction, Objects and ADTs with example, Constructors and destructors, Data structure, methods, Pre and post conditions, C conventions, Error handling, some programming language notes. Data structures: Arrays; lists; stacks and stack frames; Recursion -Recursive functions with example of factorial, Queue, Degeue.

Unit II: Searching, Queues and Sorting, Sequential and binary search, Trees, binary search tree, complexity. Red-Black trees, AVL trees, general n-ary trees, hash tables; Hashing and collision resolution, Priority queues and heaps, Sorting: Bubble, Heap, Quick, Bin, Radix, Dynamic algorithm Fibonacci numbers, bionomial coefficients, optimal binary search trees, matrix chain multiplication, longest common subsequence, optimal triangulation.

Unit III: Graphs, Minimum spanning tree and Djkstra's algorithm, Huffman encoding, FFT, Hard or intractable problems Eulerian or Hamiltonian paths, Travelling salesman problem.

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding different types of data structures and their working principle	CO1
2	Able to describe different Data structures	CO2
3	Explain various sorting and searching algorithms.	CO3
4	Describe and solve computational problems including graphs and encoding.	CO4

Text & References:

Text:

- Data Structures and Algorithms, A.V. Aho, J.E. Hopcroft and J. Ullman, Addison-Wesley Publishing
- Database Design, Development and Deployment with Student CD, P. Rob and E. Semaan, McGraw-Hill/Irwin
- Schaum's Outline of Data Structures with C++, J.R. Hubbard, McGraw Hill Trade.
- Database system concepts, A. Silberschatz, P.B. Galvin and G. Gagne, John Wiley and Sons Inc.
- Introduction to Data Structures and Application, J. Tremblay and P.G. Sorensen, McGraw Hill College Division

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

DATA STRUCTURE & ALGORITHM DESIGN LAB

Credit Units:0-0-1
Course contents:

Unit I :

Stack implementation through arrays, link list, Programs for recursion functions, Implementation of queues and leap structures, Application of binary trees in pre-order, post-order and in-order evaluation,

Unit II : A VL tree implementation, Optimal matrix multiplication

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding and implementation of different data structures	CO1
2	Understanding of Binary Trees and implementation for expression evaluation.	CO2
3	Describe and implement dynamic algorithm for Matrix Chain Multiplication.	CO3
4	Implement of Recursion Function, Heap and Queues Data Structures.	CO4

Text & References:

Text:

- Data Structures and Algorithms, A.V. Aho, J.E. Hopcroft and J. Uilman, Addison-Wesley Publishing
- Database Design, Development and Deployment with Student CD, P. Rob and E. Semaan, McGrawHill/Irwin
- Schaum's Outline of Data Structures with C++, J.R. Hubbard, McGraw Hill Trade.

References:

- Database system concepts, A. Silberschatz, P.B. Galvin and G. Gagne, John Wiley and Sons Inc.
- Introduction to Data Structures and Application, J. Tremblay and P.G. Sorensen, McGraw Hill College Division

STATISTICS AND PROBABILITY FOR ANALYTICS

Credit Units:3-0-0

Course Contents:

Introduction to Data analysis and Types : Data Analysis Types of Data Analysis – Descriptive, Exploratory, Predictive, Inferential, Steps in Data Analysis

Unit 1: Descriptive Statistics

Statistics: Preliminary concepts; Measures of Central Tendency: Mean, Median, Mode Measures of Dispersion: Range, Standard deviation, Variance, Covariance, Graphical Representation of Statistics: Histograms, Bar plots, Scatter plots etc.

Unit 2: Probability: Random Experiments, Trial and Event, Sample Space, Mutually Exclusive or Disjoint Events, Mutually Exhaustive Events, Equally Probable Events, Complementary Event, Classical definition of Probability, Statistical definition of Probability, Axiomatic definition of Probability, Addition theorem, Multiplication theorem, Conditional Probability, Bayes' Theorem. Expectation. Continuous Distribution: Normal Distribution, Properties of Normal distribution

Unit 3: Correlation: Bivariate distribution Correlation, Types of Correlation, Simple Correlation Coefficient for ungrouped data, Properties and Interpretation of Correlation Coefficient, Coefficient of determination, Scatter diagram, Standard Error, Probable error of Correlation Coefficient. Rank correlation, Some examples.

Unit 4: Introduction to the Inferential Statistics: Parameter, Statistic, Null hypothesis, Alternative hypothesis, Critical region, Type1 Error, Type 11 Error, Level of significance, P-value and its applications. Test of Significance for Small samples: One sample t-test, Paired t-test, Degrees of freedom for t-test, F test for equality of Population variances, Degrees of freedom for F-test. Test of Significance for Large samples: Normal test for sample mean and population mean, Normal test for two sample means. Chi-square Test: Test of goodness of fit, Test of Independence of attributes, Degrees of freedom for Chi Square test, Coefficient of contingency, Yates' correction for continuity. Analysis of Variance: One way and Two way (only Examples) , Introduction to Model Building: Basics of Model building, Definition of a Model, Point estimation, Confidence intervals, Testing

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the basics of statistics and their advancement for big data analysis	CO1
2	Description of data points distribution to understand their range, central tendencies (mean, median), and dispersion (variance, standard deviation).	CO2
3	Understanding various graphics plots such as bar, histogram and pi-chart etc.	CO3
4	Understanding probability, correlation and their application	CO4
5	Identification of statistical errors and methods for a data set	CO5

Text & References:

- A first course in Probability, Sheldon Ross
- An introduction to Probability and Statistics, Vijay K. Rohatgi and A. K. Md. Ehsanes Saleh
- Biostatistics: A foundation for analysis in the Health Sciences, W.W Daniel. Publisher: John Wiley and Sons.
- Biostatistics, P.N Arora and P.K Malhan. Publisher: Himalaya Publishing House.
- S. Ross, A First Course in Probability, 10th ed. Boston, MA: Pearson, 2018, ISBN: 978-0134753119.
- L. Wasserman, All of Statistics: A Concise Course in Statistical Inference, 1st ed. New York, NY: Springer, 2004, ISBN: 978-0387402727.
- G. Casella and R. L. Berger, Statistical Inference, 2nd ed. Boston, MA: Cengage Learning, 2001, ISBN: 978-0534243128.

- An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 978-1071614174
- Practical Statistics for Data Scientists, Peter Bruce, Andrew Bruce, Peter Gedeck, O'Reilly Media, 978-1492072942

STATISTICS AND PROBABILITY FOR ANALYTICS LAB

Credit Units: 0-0-1

Course Contents:

Unit 1: Descriptive Statistics: Calculation and interpretation of Descriptive Statistics

Unit 2: Probability: Understanding the preliminary concepts of probability through case studies, Continuous Distribution: Generation of statistical distributions

Unit 3: Correlation: Calculation of correlation understanding and interpreting correlation through case studies

Unit 4: Introduction to the Inferential Statistics: Understanding inferential statics through case studies, Introduction to Model Building: Understanding Basics of Model building, Definition of a Model, Point estimation, Confidence intervals, Testing through case studies

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the basics of statistics and their advancement for big data analysis	CO1
2	Description of data points distribution to understand their range, central tendencies (mean, median), and dispersion (variance, standard deviation).	CO2
3	Understanding various graphics plots such as bar, histogram and pi-chart etc.	CO3
4	Understanding probability, correlation and their application	CO4
5	Identification of statistical errors and methods for a data set	CO5

Text & References:

- A first course in Probability, Sheldon Ross
- An introduction to Probability and Statistics, Vijay K. Rohatgi and A. K. Md. Ehsanes Saleh
- Biostatistics: A foundation for analysis in the Health Sciences, W.W Daniel. Publisher: John Wiley and Sons.
- Biostatistics. P.N Arora and P.K Malhan. Publisher: Himalaya Publishing House.
- Practical Statistics for Data Scientists, Peter Bruce, Andrew Bruce, Peter Gedeck, O'Reilly Media, 978-1492072942

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering

Faculty of Engineering, SMVDU

Kakryal, Katra 182320

Research Methodology

Credit Units: 3-0-0

Course Contents:

Unit 1: Research: Definition, Characteristics, Objectives, Research and Scientific method Types of Research: Descriptive vs. Analytical Research, Applied vs. I, Fundamental Research, Quantitative vs. Qualitative Research, Conceptual vs. Empirical Research, Research Problem: Research Problem, Selecting the problem, Necessity of Defining the problem, Technique Involved in Defining a Problem.

Unit 2: Research Design, and Data Collection: Research Design: Meaning, Need, Features of Good Design, Concepts, Relating to Research Design, Different Research Design, Basic Principle of Experimental Designs. Data Collection: Observation Method, Interview Method, Questionnaires, Case Study Method. Big Data and Data Science, why data science? Who is a Data Scientist? Data Science Life Cycle

Unit 3: Data Science Process: Overview, defining goals, Retrieving data, Data preparation, Data exploration, Data modeling, Presentation. Sampling, Measurement and Scaling Techniques Sampling: Steps in Sampling Design, Different Types of Sample Designs, Measurement and Scaling: Measurement in Research, Measurement Scales, Technique of Developing Measurement Tools, Scaling, Important Scaling Techniques. Data processing: Data description, Data processing, Importance of data preparation, feature engineering and scaling of datasets, Data imbalance, Data normalization and standardization, Treatment of missing values

Unit 4: Ethics in Research and Data Science: Research ethics, Data Science ethics: Doing good data science, – Owners of the data, Valuing different aspects of privacy, Getting informed consent, The Five Cs, Diversity, Inclusion. Report Writing: Significance of Report Writing, Different Steps in Writing Report, Layouts of Research Report, Types of Reports, Oral Presentation, Mechanics and Precautions for Writing Research Report.

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the Fundamentals of Research, formulation of research problems and hypothesis	CO1
2	Understanding how to collect data, ethics in data collection and preprocessing of data	CO2
3	Basic understanding of Ethical and Legal Aspects of Research	CO3
4	Making review of research, writing reports and presentation	CO4

Text & References:

- An Introduction to Data Science, Jeffrey Stanton, Syracuse University, SAGE Publications, Inc, ISBN: 978-1506377537, 2017
- A Simple Introduction to DATA SCIENCE, Lars Nielsen, Noreen Burlingame
- Introduction to Data Science, DAN POTTER, CARSTEN BINNING,ELI UPFAL

- Davy Cielen and Arno Meysman, Introducing Data Science. Simon and Schuster, 2016.
- M. Loukides, H. Mason, and D. Patil, Ethics and Data Science. O'Reilly Media, 2018.
- C. R. Kothari, Research Methodology Methods and Techniques. 3rd. ed. New Delhi: NewAge International Publishers, Reprint 2014.
- Zina O'Leary, The Essential Guide of Doing Research. New Delhi: PHI, 2005

Mathematics Essential

Credit Units-NC

Course Contents:

Unit1: Set Theory - Number system, Sets and their operations, Relations and functions - Relations and their types, Functions and their types, Sequence and Limits - Function of One variable - Function of one variable, Graphs and Tangents, Limits for sequences, Limits for function of one variable, Limits and Continuity

Unit 2: Linear algebra, vector spaces and transformations in n-dimensions. Matrix Operations (Addition, Multiplication, Inversion), formulating and solving linear systems as matrix-vector equations, performing basic computations involving matrix algebra, orthogonal projections, and eigenvalue-eigenvector problems. Singular Value Decomposition (SVD), Principal Component Analysis (PCA)

Unit 3: Derivatives, Tangents and Critical points - Differentiability and the derivative, Computing derivatives and L'Hˆopital's rule Derivatives, tangents and linear approximation, Critical points: local maxima and minima, Partial Derivatives,

Course Outcome:

S.N.	Course Outcome	CO
1	Establishment of fundamental aspect of mathematics	CO1
2	Development of analytical and problem solving skills	CO2
3	Understanding of linear algebra, vector space, operation on matrices etc	CO3
4	Finding optimization : local maxima and minima, derivatives	CO4

Text & References:

- G. Strang, Linear Algebra and Its Applications, 4th ed. Boston, MA: Cengage Learning, 2006, ISBN: 978-0030105678.
- Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press, 978-1108455145
- C. D. Meyer, Matrix Analysis and Applied Linear Algebra, 1st ed. Philadelphia, PA: SIAM, 2000, ISBN: 978-0898714548.

- Stewart, Calculus: Early Transcendentals, 8th ed. Boston, MA: Cengage Learning, 2015, ISBN: 978-1285741550.
- S. Boyd and L. Vandenberghe, Convex Optimization, 1st ed. Cambridge, UK: Cambridge University Press, 2004, ISBN: 978-0521833783.
- M. P. Deisenroth, A. A. Faisal, and C. S. Ong, Mathematics for Machine Learning, 1st ed. Cambridge, UK: Cambridge University Press, 2020, ISBN: 978-1108455145.

INTRODUCTION TO LINUX AND DATABASE TECHNOLOGIES

Credit Units: 2-0-1

Course Contents:

Unit 1: Operating System: Difference between Windows and Unix/Linux, Definition; Concepts; Function of Operating System; UNIX/LINUX Operating Systems Concepts; Layers of UNIX; Tree Structure of UNIX; Root File System; /bin Directory; /dev Directory; /bin Directory; /etc Directory; /lib Directory; /proc Directory; /mnt Directory; /root Directory; /sbin Directory; /tmp Directory; /var Directory; Relative Path; Absolute Path; Creation of Directory; Creating file; removing file; Listing Files and Directories copying file; renaming file; Changing File Permission; Changing Directory Permission; Changing Group; Changing Owner; Pipe; Filters; pwd command; date command; head command; tail command less command; more command; grep command; VI Editor (Creating a new File; Inserting Text in File; Deleting Text in File; Copy , Cut & Paste Text; Save File). System monitoring, process information, log files, run levels, Introduction to Process in Unix/Linux: Process; Process State (New, Running, Waiting, Ready, Termination); Introduction to Management of Memory; Swapping Virtual Memory; Paging.

Unit 2: Introduction: Relational Databases, NoSQL Databases, Multimodal Databases. Working with Relational Databases using SQL (Structured Query Language), Data Definition Language (DDL), Data Manipulation Language (DML), Basic SQL queries, Integrity constraints on tables,Data Control Language Commands(DCL): Grant and Revoke SQL Functions, SQL querying to do operations such as identifying nulls, special characters, blank rows/columns, and run distributions, run data summaries, merge tables, get unique counts, SQL Joins, Aggregate functions and GROUP BY, Nested queries and sub queries. GROUP BY CLAUSE along basic aggregations such as SUM, COUNT, AVG RANK(), ROWNUM() & DENSE_RANK, UNION and UNION ALL CASE statement. Introduction to Advanced SQL concepts: Indexes, Sequence, Clusters, Views, Cursors and Triggers, Embedded SQL, Introduction to SQLITE

Unit 3: Introduction to NoSQL and its capabilities, Contrast MySQL with NOSQL, MongoDB: A Database for the internet, MongoDB's key features, Diving into the MongoDB shell, Introduction to Creating and Querying with indexes, basic Administration and writing Program using MongoDB. Application Development in MongoDB and processing MongoDB Mastery: Indexing and query optimization, Text Search, MongoDB vs Apache Cassandra: Big Data and Apache Cassandra, Importance of Cassandra, Cassandra as a Distributed Database, Cassandra as a Schema Free Database.

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the fundamentals of computer and operating system	CO1
2	Understand Linux operating system, file structure and basic commands	CO2
3	Establishment of basic understanding of databases: SQL - and NO-SQL databases	CO3
4	Ability to work with SQL commands and interaction with database	CO4
5	To identify the need and working with NO-SQL databases in Data Science	CO5

Text & References:

- Peter Baer Galvin. 2016. Operating System Concepts. BPB Publication · Stuart E. Madnick. 2001. Operating System. Tata Mac Graw Hill.
- Kenneth H. Roshan. 2007. The complete reference Unix Tata Mac Graw Hill..
- D. M. Dhamethire. , 2011. System Programming and Operating Systems. Tata Mac Graw Hill.
- Kirrgcox. 2001. Red Hat Linux by. Printice Hill India.
- Andrew S. Talenbaum. 2008. Modern Operating system. Printice Hill India.
- Sumetabha Das. 2013. Unix (Concept and Application). Tata Mac Graw Hill.
- Ramesh Bangia. 2015. Learning Unix. BPB Publication.
- Database System Concepts, Abraham Silberschatz, Henry F. Korth, and S. Sudarshan
- An Introduction to Database Systems, C J Date
- Fundamentals of Databases -- Elmasri and Navathe.
- Database Management Systems – Raghu Ramakrishna, Johannes Gehrke
- MongoDB: The definitive guide by Kristina Chodorow, Michael Dirolf
- Cassandra: The Definitive Guide, Eben Hewitt
- MangoDB in Action, Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, Tim Hawkins

PROGRAMMING IN R

Credit Units: 2-0-2

Course Contents:

Unit 1: An Introduction to R. Overview of R programming, applications, usage and comparative study with other softwares and introduction to R for Data Science, Setting up the R environment and packages. Setting up R environment and install packages and supporting libraries in R, Basics of R : Manage your data and workspace, Save your work, How to use R, Data structure in R, Data creation and curation and special function using R, Matrices and Lists .

Unit 2: File Handling: Reading different file format using R, file handling and processing, writing output file. Graphics using R: Graphics device, Basic plot function, scatter plot, 3-D scatter plot, pair plots, Lineplot, Matplot Matpoints, Bar plot, Histogram plot, Density plot, Dot plot, Pie chart, Venn diagram, Grid graphics, Lattice, ggplot2, Interactive plotting, combine multiple plots in same graphics screen, save graphics to a file., Conditional Executions, Comparison Operators, Logical Operators,

Control Structures, If statements, Ifelse statements, Loops, For loop, While loop, Apply loop family, Other loops,

Unit 3: Functions: Define and Call functions, Syntax Rules for functions, Control utilities for functions, Writing own function, Advance R, Advance R functions and Regular expressions, Object oriented programming, Building R package

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the concept of programming in R and basic of setup environment	CO1
2	Develop Skills for Data Manipulation	CO2
3	Enable Data Visualization	CO3
4	Perform statistical analysis on various datasets	CO4
5	Application of R in machine learning and artificial intelligence	CO5

Text & References:

- A Handbook of Statistical analysis using R, Brain Everitt and Torsten Hothorn
- The art of R programming, Norman Matloff
- Data Analysis and Graphics using R, W. John Braun
- R Graphics, Paul murrell
- R for Data Science, Garrett Grolemund and Hadley Wickham
- Linear Models with R, Julian J. Faraway
- An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 978-1071614174

PROGRAMMING IN PYTHON

Credit Unit: 02-0-02

Course Contents:

Unit 1: Introduction to Python: Overview of Python, applications, usage and comparative study with other software. Basics of Python : Syntax, Data Types, Variables, Operators, Input/output, Flow of Control (Modules, Branching), Basic Programming with Python:If, If- else, Nested if-else, Looping, For, While, Nested loops, Control Structure, Break, Continue, Pass,

Unit 2: Data Structures of Python: Strings and Tuples, Accessing Strings, Basic Operations, String slices, Working with Lists, Introduction, Accessing list, Operations, Function and Methods, Files, Modules, Dictionaries, Functions and Functional, Programming, Declaring and calling Functions, Declare, assign and retrieve values from Lists, Introducing Tuples, Accessing tuples

Unit 3: Advanced Python: Object Oriented, OOPs concept, Class and object, Attributes, Inheritance, Overloading, Overriding, Data hiding, Operations Exception, Exception Handling, Except clause, Try

finally clause, User Defined Exceptions, Python Libraries : Introduction to Machine learning packages like NUMPY, SCIPY, PANDAS etc.

Course Outcome:

S.N.	Course Outcome	CO
1	Establishment of fundamental of programming in python and basic setup	CO1
2	Develop Skills for Data Manipulation	CO2
3	Perform statistical analysis on various datasets	CO3
4	Application of python in machine learning and artificial intelligence	CO4

Text & References:

- Think Python by Allen B. Downey
- Introducing Python by Bill Lubanovic
- Hello World by Warner Sande and Carter Sande
- Learning Python , 5th Edition , Mark Lutz
- Python For Data Analysis by W Mckinney
- Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media

BIG DATA TOOLS & TECHNOLOGIES-I

Credit Units: 2-0-2

Course Contents:

Unit 1: Introduction to Big Data Big Data and its Importance, V's of Big Data, Drivers for Big Data, Introduction to Big Data Analytics, Big Data Analytics applications. Characteristics of Data: Structured, Semi-structured and Unstructured data, data at rest, data in motion, etc, good data versus bad data, Challenges in handling large data sets,

Unit 2: Introduction to Hadoop: Hadoop Introduction, Hadoop key characteristics, Hadoop Core Components, Hadoop Ecosystem, Hadoop Services, Different Hadoop Modes, Hadoop's Parallel World – Data discovery, Hadoop Installation, Hadoop Cluster Setup, Storing Data in Hadoop, HDFS Commands (Basics, Intermediate and Advanced), Processing your data with Map Reduce, Run test example using Map reduce, Distributed Cache, Map side join vs Reduce Side Join, Running Hadoop applications, Processing Big Data: Integrating disparate data stores, Mapping data to the programming framework, Connecting and extracting data from storage, Transforming data for processing, Subdividing data in preparation for Hadoop Map Reduce. Hadoop Map Reduce: Employing Hadoop Map Reduce, Creating the components of Hadoop Map Reduce jobs, Executing / Monitoring Hadoop Map Reduce jobs,

Unit 3: Fundamental of Apache Pig: What is Pig?, Introduction to Pig Data Flow Engine, Pig and Map Reduce in Detail, When should Pig Used?, Pig and Hadoop Cluster, Pig Interpreter and Map Reduce, Pig Relations and Data Types, Debugging and Generating Example in Apache Pig, Pig philosophy and architecture, Pig installation, Grunt shell, Loading data, Exploring Pig Latin commands, Pig Transformations functions, Joins in Pig, Hands on Exercises

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering

Faculty of Engineering, SMVDU

Kakryal, Katra 182320

Unit 4: Fundamental of Apache Hive: What is Hive?, Architecture of Hive, Hive Services, Hive Clients, How Hive Differs from Traditional RDBMS, Introduction to HiveQL, Data Types and File Formats in Hive, File Encoding , Common problems while working with Hive Hive architecture, Hive installation, Hive vs. RDBMS, HiveQL and the Hive shell, Data types and schemas, Creating tables (external vs. managed), Creating Partitions, Creating Views, UDF function in java in Hive, Using hive to create diff types of format

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the concept of big data, characters of big data and structure	CO1
2	Establishment of platform to handle and manipulate big-data	CO2
3	Apply Hadoop, Apache pig and hive palatiform to big data analytics	CO3
4	To acquire skills for Challenges in handling large data sets	CO4

Text & References:

- Big Data and Analytics, Seema Acharya , Subhashini Chellappan
- Professional Hadoop Solution, Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich
- Programming PiG, Wiley Publication, Alan Gates
- Programming Hive, Wiley Publication, Jason Rutherglen, Dean Wamplor & Edward Capriolo

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the principles of autoregressive-moving average models (ARIMA)	CO1
2	Estimation of coefficients in ARIMA processes	CO2
3	Explain the methodology for forecasting	CO3
4	Apply time series models to real-world datasets for forecasting and decision-making applications.	CO4

Text & References:

- Enders W. Applied Econometric Time Series. John Wiley & Sons, Inc., 1995
- Mills, T.C. The Econometric Modelling of Financial Time Series. Cambridge University Press, 1999
- Andrew C. Harvey. Time Series Models. Harvester wheatsheaf, 1993.

CLOUD COMPUTING

Credit Units: 02-0-02

Course contents:

Unit 1: Introduction to cloud computing: History and evolution, Properties, Characteristics & Disadvantages, Pros and Cons of Cloud Computing, Benefits of Cloud Computing, AWS, Azure, Fundamentals of Cloud Computing: the primary deployment and service models., data warehousing, components, and architectures of data warehousing,

Unit 2: Cloud Computing Architecture: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Cloud Deployment Model: Cloud computing platform, Private cloud deployment, Public cloud deployment, Hybrid cloud deployment

Unit 3: Cloud security: Data on virtual network, Infrastructure Security, Network-level security, Host level security, Data Security and Storage, Cloud Access: authentication, authorization, and accounting

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the basic principle of cloud computing and service model	CO1
2	How cloud computing serve as cost effective and scalable platform	CO2
3	Enable students to deploy data science models and use of cloud computing instances	CO3
4	Establishment of data security protocols	CO4

Text & References:

- Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Shahed Latif, Subra Kumaraswamy, and Tim Mather
- Enterprise Cloud Computing: Technology, Architecture, Applications, Gautam Shroff,
- Cloud Computing: Concepts, Technology & Architecture, Ricardo Puttini, Thomas Erl, and Zaigham Mahmood

PATTERN RECOGNITION

Credit Units: 2-0-02

Course contents:

Unit 1: Introduction: The basic concepts of pattern recognition, such as frequent pattern, closed pattern, max-pattern, and association rules. Pattern mining methods (Clustering, Apriori, ECLAT, and FPgrowth), pattern evaluation: lift, chi-square, cosine, Jaccard, and Kulczynski,

Unit 2: Methods for recognition of multi-level patterns: multi-dimensional patterns, qualitative patterns, negative correlations, compressed and redundancy-aware top-k patterns, and mining long (colossal) patterns.

Unit 3: Sequential pattern recognition methods: GSP, SPADE, PrefixSpan, and CloSpan, Graph pattern recognition methods: subgraph pattern mining, such as gSpan, CloseGraph, graph indexing methods, mining top-k large structural patterns in a single large network, and graph mining applications, such as graph indexing and similarity search in graph databases.

Unit 4: Use of Dictionary learning and collaborative filtering in pattern recognition, Pattern recognition applications: spatiotemporal and trajectory patterns, pattern mining in data streams, software bug mining, pattern discovery for image analysis

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the basic concept of pattern recognition, mining and evolution method	CO1
2	Finding multilevel patterns	CO2
3	Application of Sequential pattern recognition methods	CO3
4	Modern approaches to filter patterns such as dictionary learning	CO4

Text & References:

- R.Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, John Wiley & Sons, NY, 1992.
- Duda R O and P E Hart, Patten classification and scene analysis, John Wiley & Sons, NY 1973
- K.S.Fu, Syntactic pattern recognition and applications, Prentice Hall, NJ, 1982
- T.Pavlidis, Structural pattern recognition, Springer-Verlag, NY, 1977

- D.H.Ballad and C.M.Brown, Algorithms for computer vision, Prentice Hall, 1982

Syllabus - Third Semester

DEEP LEARNING & NEURAL NETWORKS

Credit Units:3-0-0

Course Contents:

Unit 1: Introduction to neural networks: Conceptual overview of neural network, Supervised Learning with Neural Networks, Neural Network Representation, Computing a Neural Network's Output, Vectorizing across multiple examples, Activation functions, Derivatives of activation functions, weights and bias, Shallow neural network

Unit 2: Optimization methods: Gradient based methods, Gradient descent, Learning rate, Batch gradient descent, mini batch gradient descent, stochastic gradient descent method. Gradient free methods, Exhaustive search, Genetic algorithm, Simulated annealing,

Unit 3: Deep Neural Networks: Deep L-layer neural network, Building blocks of deep neural networks, Forward and Backward Propagation, Parameters vs Hyperparameters. Convolution neural network Introduction: stride, Pooling, Flatten layers, fully connected layers.

Unit 4: Generative AI models: Introduction to generative AI and its component, Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), Boltzmann Machines (BMs):

Course Outcome:

S.N.	Course Outcome	CO
1	Fundamental concepts of deep learning and its importance in solving complex data science problems.	CO1
2	Provide understanding of architecture, components, operations and optimization of models	CO2
3	Describe classifiers used in neural network and deep neural network: illustrate their application on large datasets.	CO3
4	Enable practical skills in designing, training, and validating deep learning models	CO4

Text & References:

- Deep learning: adaptive computation and machine learning, Bengio, Yoshua, Courville, Aaron, Goodfellow, Ian J
- Deep Learning: A Practitioner's Approach, J. Patterson, A. Gibson · Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal · Neural Networks and Deep Learning, Michael Nielsen.

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

DEEP LEARNING & NEURAL NETWORKS LAB

Credit Units:0-0-1
Course Contents:

Unit 1: Neural networks: Getting ready with your first neural network, Vectorizing across multiple examples, Calculation of Activation functions, weights and bias, Shallow neural network

Unit 2: Deep Neural Networks: Deep L-layer neural network, Building blocks of deep neural networks, Forward and Backward Propagation, Parameters vs Hyperparameters. Convolution neural network: Introduction, stride, Pooling, Flatten layers, fully connected layers.

Unit 3: Generative AI models: Application of generative AI models, Case study using real world data: Building a neural network model and generating predictions from the model using tensorflow or keras.

Course Outcome:

S.N.	Course Outcome	CO
1	Fundamental concepts of deep learning and its importance in solving complex data science problems.	CO1
2	Provide understanding of architecture, components, operations and optimization of models	CO2
3	Describe classifiers used in neural network and deep neural network; illustrate their application on large datasets.	CO3
4	Enable practical skills in designing, training, and validating deep learning models	CO4

Text & References:

- Deep learning: adaptive computation and machine learning by Bengio, Yoshua, Courville, Aaron, Goodfellow, Ian J
- Deep Learning: A Practitioner's Approach by J. Patterson, A. Gibson
- Neural Networks and Deep Learning: A Textbook by Charu C. Aggarwal
- Neural Networks and Deep Learning by Michael Nielsen

GENERALIZED & LINEAR MODELING

Credit Units:3-0-1

Course Contents:

Unit 1: Introduction to Generalized Linear Models: Linear model, Non linear model, GLM, Linear Regression Models: Multiple regression model, Parameter estimation, Maximum likelihood, Model adequacy checking, Weighted least squares

Unit 2: Nonlinear Regression Models: Linear and Nonlinear regression models, transforming a linear model, Parameter estimation Logistic and Poisson Regression Models: Logistic regression, Poison regression, Overdispersion

Unit 3: The Generalized Linear Model: Exponential family, Likelihood equations, Quasi likelihood, Gamma family, The power function, Generalized Estimating Equation, ordinary least squares (OLS), model selection and evaluation: AIC, BIC, cross-validation, and likelihood ratio tests.

Course Outcome:

S.N.	Course Outcome	CO
1	Understand the theory and assumptions underlying linear regression models	CO1
2	Analyse and interpret the results of linear regression and multiple-linear regression	CO2
3	Application of Nonlinear Regression Models and OLS	CO3
4	Conduct model selection and evaluation	CO4

Text & References:

- Generalised Linear Models: With Applications in Engineering and the Sciences by Raymond H. Mysers, Douglas C. Montgomery, G. Geoffrey Vining, Timothy J. Robinson
- Data Analysis Using Regression and Multilevel/ Hierarchical Models, Andew Gelman and Jennifer Hill
- Categorical data analysis, Ala Agresti

GENERALIZED & LINEAR MODELING LAB

Credit Units: 0-0-1
Course contents:

Unit 1: Linear Regression Models:
Multiple regression model, Parameter estimation, Maximum likelihood, Model adequacy checking, Weighted least squares with case studies

Unit 2: Nonlinear Regression Models: Linear and Non linear regression models, transforming a linear model, Parameter estimation with case studies, **Logistic and Poisson Regression Models:** Logistic regression, Poison regression, Overdispersion with case studies

Unit 3: The Generalized Linear Model: Exponential family, Likelihood equations, Quasi likelihood, Gamma family, The power function, Generalized Estimating Equation with case studies. ordinary least squares (OLS), model selection and evaluation: AIC, BIC, cross-validation, and likelihood ratio tests.

Course Outcome:

S.N.	Course Outcome	CO
1	Understand the theory and assumptions underlying linear regression models	CO1
2	Analyse and interpret the results of linear regression and multiple linear regression	CO2

3	Application of Nonlinear Regression Models and OLS	CO3
4	Conduct model selection and evaluation	CO4

Text & References:

- Generalised Linear Models: With Applications in Engineering and the Sciences by Raymond H. Mysers, Douglas C. Montgomery, G. Geoffrey Vining, Timothy J. Robinson
- Data Analysis Using Regression and Multilevel/ Hierarchical Models, Andew Gelman and Jennifer Hill
- Categorical data analysis, Ala Agresti

GRAPH & SOCIAL NETWORK ANALYSIS

Credit Units: 3-0-0

Course Contents:

Unit 1: Introduction to graph theory : Use of graph theory to construct different types of networks : Undirected, directed graphs, Cyclic, Directed acyclic graphs, trees, weighted graphs, bipartite graph, Study data structures of the graphs. Adjacency matrix, adjacency list. Study different network models : Small world phenomena, Scale free network, Erdös-Rényi model for random graphs, Watts and Strogatz model, Barabasi-Albert model

Unit 2: Study network properties: Degree distribution, power law, graph density, graph isomorphism, path length, diameter, clique, shortest distance, clustering coefficient, network motifs, network centralities and node ranking, degree centrality, closeness centrality, betweenness centrality, eigenvector centrality, ecentricity centracility, subgraph centrality, matching index, Network randomization: Randomization with Erdös-Rényi model, Randomization with node degree conservation, Permutation of node labels

Unit 3: Introduction to social network: Introduction to social network data, Different data format, Paths and Connectivity-Graphs to represent social relations. Working with network data- Network Datasets-Strong and weak ties - Closure, Structural Holes, and Social Capital.: Data and Text Mining In Social Media: Data mining in nutshell, Social media, Motivations for data mining in social media, Data mining methods for social media. Social networking sites: illustrative examples. Text Mining: Keyword search, query semantics and answer ranking, Classification algorithms, Clustering algorithms., Community Detection in Social Networks: Introduction, Communities in context, core methods and algorithm for community detection, Quality functions, Agglomerative/Divisive algorithms, discuss different approached for clustering.

Course Outcome:

S.N.	Course Outcome	CO
1	Understand and explain fundamental concepts of graph theory, network science and graph representation methods	CO1
2	Apply different network models	CO2

3	Analyse and compute key network properties	CO3
4	Investigate the behaviour of social networks	CO4

Text & References:

- Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010
- Social and Economic Networks by Matthew O. Jackson, Princeton University Press, 2010.
- Easley and Kleinberg, "Networks, Crowds, and Markets: Reasoning about a highly connected world", Cambridge Univ. Press, 2010.
- Charu C. Aggarwal, "Social Network Data Analytics", Springer, 2011.
- Robert A. Hanneman and Mark Riddle, "Introduction to social network methods", University of California, 2005.
- Jure Leskovec, AnandRajaraman, and Jeffrey D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2 edition, 2014.
- Wasserman, S., & Faust, K, "Social Network Analysis: Methods and Applications", Cambridge University Press; 1 edition, 1994.

GRAPH & SOCIAL NETWORK ANALYSIS LAB

Credit Units: 0-0-1

Course contents:

Unit 1: Study Tools for graphs and network study : Case studies will be implemented by using any programming language such as R or python. Learn other tools like Cytoscape and Gephi, and igraph, Introduction to graph theory: Input graph data : Read different network format, load network data, Construct network from matrix, Adjacency matrix. Input different types of networks : Undirected, directed graphs, Cyclic, Directed acyclic graphs, trees, weighted graphs, bipartite graph. Study data structures of the graphs. Adjacency matrix, adjacency list. Study different network models : Small world phenomena, Scale free network, Erdös-Rényi model for random graphs, Watts and Strogatz model, Barabasi-Albert model

Unit 2: Study network properties: Degree distribution, power law, graph density, graph isomorphism, path length, diameter, clique, shortest distance, clustering coefficient, network motifs, network centralities and node ranking, degree centrality, closeness centrality, betweenness centrality, eigenvector centrality, ecentricity centracility, subgraph centrality, matching index, Network randomization: Randomization with Erdös-Rényi model, Randomization with node degree conservation, Permutation of node labels

Unit 3: Introduction to social network: Introduction to social network data, Different data format, Paths and Connectivity-Graphs to represent social relations. Working with network data- Network Datasets-Strong and weak ties - Closure, Structural Holes, and Social Capital., Data and Text Mining In Social Media, Data mining in nutshell, Social media, Motivations for data mining in social media, Data mining methods for social media. Social networking sites: illustrative examples. Text Mining: Keyword search, query semantics and answer ranking, Classification algorithms, Clustering algorithms., Community Detection in Social Networks: Introduction, Communities in context, core

methods and algorithm for community detection, Quality functions, Agglomerative/Divisive algorithms, discuss different approached for clustering.

Course Outcome:

S.N.	Course Outcome	CO
1	Understand and explain fundamental concepts of graph theory, network science and graph representation methods	CO1
2	Apply different network models	CO2
3	Analyse and compute key network properties	CO3
4	Investigate the behaviour of social networks	CO4

Text & References:

- Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010
- Social and Economic Networks by Matthew O. Jackson, Princeton University Press, 2010.
- Easley and Kleinberg, "Networks, Crowds, and Markets: Reasoning about a highly connected world", Cambridge Univ. Press, 2010.
- Charu C. Aggarwal, "Social Network Data Analytics", Springer, 2011.
- Robert A. Hanneman and Mark Riddle, "Introduction to social network methods", University of California, 2005.
- Jure Leskovec, AnandRajaraman, and Jeffrey D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2 edition, 2014.
- Wasserman, S., & Faust, K, "Social Network Analysis: Methods and Applications", Cambridge University Press; 1 edition, 1994.

NATURAL LANGUAGE PROCESSING

Credit Units: 2-0-02

Course Contents:

Unit 1: Introduction to text mining: Introduction, Challenges of Text Processing, Character-Set Dependence, Language Dependence, Corpus Dependence, Application Dependence, Exploring Text Data For Preliminary Ideas: A case study for a brief introduction, Examine multiple document corpus of text, Creation of text corpus, Text pre-processing, Stemming, Word tokenisation, Word vectorisation, Word embedding, Natural Language Processing: Sentiment Analysis, Word Frequency in text data, Wordclouds for visualizing sentiments with a case study, Wordclouds for Visualizing text data, Tidy wordclouds, Topic modelling a document

Unit 2: Text Data and Machine Learning, Clustering for text data, Clustering tweets, Regression on text data, Introduction to RTextTools, More on RTextTools, Word2Vec approach, The Doc2Vec approach, Doc2Vec approach for predicting a binary outcome, Doc2Vec approach for multi-class classification,

Unit3: Sentiment Analysis: What is sentiment, What is sentiment analysis, Scope of sentiment analysis: Document level, Sentence level, Sub-sentence level, Types of sentiment analysis, Word embeddings, Word associations or Text similarities, Building dictionaries, Summarise text, Polarity calculation, Algorithms for sentiment analysis: Rule based, Automatic Hybrid, Case study using real world data. Identify Spam-ham Emails or sms classification.

Course Outcome:

S.N.	Course Outcome	CO
1	Understand the fundamental concepts of natural language processing	CO1
2	Apply core NLP tasks such as tokenization, stemming, lemmatization, part-of-speech tagging, and named entity recognition (NER).	CO2
3	Analyse and preprocess text data using vectorization techniques	CO3
4	Understand the use of deep learning models	CO4

Text & References:

- HANDBOOK OF NATURAL LANGUAGE PROCESSING Ralf Herbrich and Thore Graepel Text Mining with R by Julia Silge and David Robinson.
- Natural Language Processing with Python by Steven Bird, Ewan Klein and Edward Loper.
- Taming Text by Grant Ingersoll, Thomas Morton and Drew Farris.
- Foundations of Statistical Natural Language Processing by Christopher Manning and Hinrich Schütze.

BIG DATA TOOLS & TECHNOLOGIES-III

Credit Units: 02-0-02

Course contents:

Unit 1: Apache Kafka: Data Acquisition: Apache Kafka Introduction, Apache Kafka Components (Producers, consumers, consumer groups, clusters, brokers, partitions, replicas, leaders, and followers) Integration with Hadoop system, Benefits of Stream Processing and Apache Kafka use Cases

Unit 2: Apache Flink: Understanding Stream Processing and Apache Flink, capabilities and its role in the big data ecosystem, Comparison to Apache spark and storm, Flink's architecture including JobManager and TaskManager roles, execution model and dataflow, parallelism, state management, and fault tolerance, DataStream API and Transformations: implementing transformations such as map, filter, flatMap, and reduce, Windowing and Time Semantics, Stateful Stream Processing, Flink Table API and SQL: Performing relational operations on streaming data using Table API. Advanced Topics: Complex Event Processing (CEP) and machine learning with Flink.

Unit 3: ElasticSearch: Data ingestion, storage, enrichment, visualization, and analysis using elasticsearch. Components including: cluster, nodes, shards, replicas, analyzers and documents

Course Outcome:

S.N.	Course Outcome	CO
1	Understand the architecture of distributed systems in handling large-scale and real-time data pipelines.	CO1
2	Design and implement real-time stream processing application	CO2
3	Apply and preparation of pipelines using Apache Kafka and Flink	CO3
4	Understand and implement Elasticsearch for full-text search, indexing, and analytics over large volumes of semi-structured data	CO4

Text & References:

- Apache Kafka Cookbook, Saurabh Minni, Packt Publishing Limited, ISBN: 978-1785882449
- Stream Processing with Apache Flink: Fundamentals, Implementation, and Operation of Streaming Applications, O'Reilly Media, 2019, 978-1491974292
- Learning Apache Flink, Packt Publishing, 2017, 978-1786466228
- Elasticsearch: The Definitive Guide: A Distributed Real-Time Search and Analytics Engine, O'Reilly Media, 2015, 978-1449358549
- Elasticsearch in Action, Second Edition, Manning Publications, 9781617299858

CUSTOMER BEHAVIOR ANALYSIS AND FRAUD DETECTION

Credit Units-02-0-02

Course contents:

Unit 1: What is "customer analytics" and why do we do it?, Specific Loyalty Matrix tools & biases. Goals, Understanding customer needs, preferences, and motivations, Quantitative data (purchase history, website traffic, social media interactions), Qualitative data (customer surveys, feedback, interviews), A Brief review of what needs to be done before serious analysis can start, Sourcing business requirements. Sourcing raw data, Profiling raw data, Data quality control & remediation.

Unit 2: Association Rule Mining (Apriori algorithm), Predictive Modeling (Predicting future customer behavior using machine learning algorithms), Segmentation & Prediction: Decision Tree method, Clustering method, Using Customer Data for Personalization, Customer Lifetime Value (CLTV) Analysis, Churn Analysis

Unit 3: Define fraud, different types of fraud, and the role of data science in fraud detection, Implementation of EDA and machine learning in fraud detection

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding the fundamentals of customer behaviour analysis	CO1
2	To be able to understand analytics to uncover patterns in customer behaviour	CO2
3	Provide skills to build customer segmentation models	CO3
4	Introduce real-time fraud detection pipelines using big data tools	CO4

Text & References:

- Behavioral Research Data Analysis with R- Yuelin Li, Jonathon Baron

BLOCKCHAIN

Credit Units: 02-0-02
Course contents:

Unit 1: Introduction: Key Innovations/Revolutions in Human History, Evolution of Economic System, Money, Ledger and Accounting, Digital Revolution & its impact across industries, Digital Money, DigiCash, E-Gold, History & Fundamentals of Blockchain, Key Elements of Blockchain, Blockchain Protocols, Benefits of Blockchain, Types of Blockchain, Centralized vs. De-centralized systems

Unit 2: Cryptography, Symmetrical vs. Asymmetrical Encryption, Secure Hash Algorithms (SHA Family), Comparison of SHA functions, Digital Signatures

Unit 3: Consensus Mechanisms – Objectives & Need, Proof of Work (PoW), Proof of Stake (PoS), Types & Functions of Node, Construct of Block, Public vs. Private Keys, Types of Ledger, Ledgers, Distributed Ledger Technology (DLT), Benefits & Use Cases of DLT, Smart Contract

Course Outcome:

S.N.	Course Outcome	CO
1	Understand the fundamental principles of blockchain technology	CO1
2	Explore how blockchain can be integrated with data science	CO2
3	Identify potential of Blockchain technology in different types of data	CO3
4	Develop simple blockchain applications	CO4

Text & References:

- Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World, 978-1101980149, 978-1260026672, Don and Alex Tapscott
- Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyon, by Chris Burniske and Jack Tatar

- The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them (Cryptography, Derivatives Investments, Futures Trading, Digital Assets, NFT) Hardcover – Illustrated, September 15, 2018, Antony Lewis,
- The Blockchain Developer: A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects 1st ed. Edition, Apress, 978-1484248461, 2019

NEXT GENERATION SEQUENCING DATA ANALYSIS

Credit Units: 02-0-02

Course contents:

Unit 1: Introduction to NGS and NGS Technologies: Introduction to sequencing technologies from a data analysts view, Concept, Applications of sequencing technologies in Whole genome assembly; Gene expression analysis; Genome annotation; Gene regulation analysis; Variation studies

Unit 2: NGS data analysis: Preprocessing: Introduction to NGS data analysis, Raw sequence files (FASTQ format), Preprocessing of raw reads: quality control (FastQC), adapter clipping, quality trimming, Introduction to read mapping (Alignment methods, Mapping heuristics), Read alignment to a reference genome (BWA, Bowtie2, TopHat), Mapping output (SAM/BAM format), Usage of important NGS toolkits (samtools, BEDtools), Mapping statistics, Visualization of mapped reads (IGV, UCSC)

Unit 3: NGS data analysis: Variant calling, DNA variant calling and Filtering DNA variants, NGS data analysis: Gene Expression Analysis, Differential Expression analysis, Quantification of expression,

Course Outcome:

S.N.	Course Outcome	CO
1	Understand the basic principles and technology in different NGS platform	CO1
2	To be able to explain the workflow of NGS data analysis	CO2
3	To be able to perform preprocessing of the data and downstream analysis	CO3
4	Design and analyse NGS-based projects.	CO4

Text & References:

- Exploring Personal Genomics, 1st Edition, Joel T. Dudley, Konrad J. Karczewski, ISBN-13: 9780199644490, Oxford University Press, 2013
- High-Throughput Next Generation Sequencing, Methods and Applications,Editors: Kwon, Young Min, Ricke, Steven C. (Eds.), ISBN 978-1-61779-089-8, Springer, 2011
- Next Generation Sequencing Technologies and Challenges in Sequence Assembly, El-Metwally, M.Sc, Sara, Ouda, Osama M., Helmy, Mohamed, ISBN 978-1-4939-0715-1, Springer 2014

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering

Faculty of Engineering, SMVDU

Kakryal, Katra 182320

Prof. Vijay Laxmi
External Expert

Dr. Sunanda
Chairman and Head SoCSE

Dr. Sakshi Arora Member	Dr. Ajay Koul Member	Mr. Manoj Kumar Verma Member	Dr. Pooja Sharma Member
Dr. Baijnath kaushik Member	Dr. Naveen Kr. Gondhi Member	Dr. Sonika Gupta Member	Mr. Sanjay Kumar Sharma Member
Dr. Deo Prakash Member	Mr. Sudesh Kumar Member	Dr. Archana Purwar Member	Dr. Rohit Tanwar Member
Dr. Vipal Kr. Sharma Member	Dr. Ravi Datta Sharma Member	Dr. Manoj Kumar Gupta Member	Mr. Anuj Mahajan Member

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering

Faculty of Engineering, SMVDU

Kakryal, Katra 182320

Annexure 'B'

Course Structure

M. Tech (Artificial Intelligence)

[Entry Batch 2025 onwards]

Semester I — First Year

S.No	Course Code	Course Title	L	T	S/P	Credit
1	CSL DC601	Machine Learning	3	0	0	3
2	CSP DC601	Machine Learning Lab	0	0	2	1
3	CSL DC603	Mathematical Foundations for AI	3	1	0	4
4	CSL DC605	Research Methodology	4	0	0	4
5	CSL DC607	Image & Video Processing	3	0	0	3
6	CSP DC607	Image & Video Processing Lab	0	0	2	1
7		Elective I	4	0	0	4
		Total Credits	17	1	4	20

Semester II — First Year

S. No	Course Code	Course Title	L	T	S/P	Credit
1	CSL DC602	Natural Language Processing	3	1	0	4
2	CSL DC604	Data Analytics	3	0	0	3
3	CSP DC604	Data Analytics Lab	0	0	2	1
4	CSL DC606	Advances in AI & ML	3	0	0	3
5	CSP DC606	Advances in AI & ML Lab	0	0	2	1
6		Elective-II	3	1	0	4
7		Open Elective-1	3	1	0	4
		Total Credits	15	3	4	20

Semester III — Second Year

S. No	Course Code	Course Title	L	T	S/P	Credit
1	CSD PR701	Dissertation Preliminary	0	0	40	20
		Total Credits				20

Semester IV — Second Year

S. No	Course Code	Course Title	L	T	S/P	Credit
1	CSD PR702	Dissertation Final	0	0	40	20
		Total Credits				20

Total credits in M.Tech (CSE) =80

Minimum Total Credits to be earned in order to become eligible for award of M.Tech. (Two Year Full Time) Degree: 80

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)
Shri Mata Vaishno Devi University
School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

List of School Electives

Course Code	Course Title	L-T-P	Credit
Elective – I			
CSL DE601	Social Media Analytics	3-1-0	4
CSL DE603	Optimization Techniques	3-1-0	4
CSL DE605	Design & Analysis of Algorithms	3-1-0	4
CSL DE607	Nature Inspired Algorithms	3-1-0	4
CSL DE609	Graph Theory	3-1-0	4
CSL DE611	Neural Networks & Fuzzy Logic	3-1-0	4

Course Code	Course Title	L-T-P	Credit
Elective II			
CSL DE602	Pattern Recognition	3-1-0	4
CSL DE604	Data Mining	3-1-0	4
CSL DE606	Soft Computing	3-1-0	4
CSL DE608	High Performance Computing	3-1-0	4
CSL DE610	Digital Twin	3-1-0	4
CSL DE612	Robotics and Vision Control	3-1-0	4

Annexure 'C'

Program Specific Outcomes (PSO)

B.Tech (CSE)
M.Tech (AI)

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

Minutes of the Meetings

Date :- 06/05/25

The regular meeting of the faculty members and the Board of studies committee members was called on May 01 2025, 4pm to discuss and formulate the program specific outcomes of the school.

The following faculty members were present in the meeting:

Dr Sunanda, Associate professor, Chairman & Head

Dr Manoj Kumar Gupta, Professor

Dr Ajay Kaul, Professor

Dr Baijnath, Associate professor

Dr Sakshi Arora, Associate professor

Dr Rohit Tanwar, Associate professor

Mr. Manoj Kumar, Assistant professor

Dr Sonika Gupta, Assistant professor

Dr Deo Prakash, Assistant professor

Dr Vipul Sharma, Assistant professor

The following agenda items were discussed and decision taken:-

Agenda item no 1: The following Program Specific ~~Objectives~~ Outcomes have been adopted for Bachelor of Technology in Computer Science & Engineering program after thorough deliberations:-

PSO 1: To be able to apply core principles of Computer Science& Engineering, to design, develop, test and maintain efficient software systems using modern programming languages and tools.

PSO 2: To be equipped to analyse, model and optimize computer-based systems and processes by applying algorithm design principles and emerging technologies, to provide solutions for real world problems.

PSO 3: To foster research aptitude; encourage interdisciplinary collaboration, and instil confidence and commitment for lifelong learning.

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)
Shri Mata Vaishno Devi University
School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

Agenda item no 2: The following Program Specific Objectives have been adopted for M.Tech (Artificial Intelligence) program under school of Computer Science & Engineering after thorough deliberations:-

PSO 1: Apply knowledge of artificial intelligence concepts to analyse and design intelligent systems that solve real-world problems.

PSO 2: Formulate and pursue research problems in AI and related domains, critically evaluate existing literature, and contribute novel ideas through scholarly publications.

The meeting ended with the vote of thanks to the chair.

Annexure 'D'

Course Code	: CSL GE301
Course Title	: Introduction to Artificial Intelligence
L-T-P/S=Credits	: 3-1-0
Course Category :	
Pre-requisite Courses (if any)	:
Equal Course Code (if any)	:
Equivalent Course Code (if any)	

Syllabus

1. Introduction to Artificial Intelligence:

- Definition and history of AI
- Importance of AI in the modern world
- Different branches of AI: Machine Learning, Expert Systems, Robotics, Natural Language Processing, etc.
- Real-world applications of AI (healthcare, finance, entertainment, etc.)

2. Fundamentals of Problem Solving in AI:

- Problem-solving techniques and strategies
- Search algorithms:
  - Uninformed search: Breadth-first, Depth-first, Uniform Cost
  - Informed search: A* search, Greedy search
- State-space representations and search trees

3. Basic Concepts in Machine Learning:

- Introduction to Machine Learning
- Types of learning:
  - Supervised Learning (classification and regression)
  - Unsupervised Learning (clustering, dimensionality reduction)
  - Reinforcement Learning (basic concepts)
- Simple machine learning models: Linear regression, k-nearest neighbors (KNN)

4. Introduction to Natural Language Processing (NLP):

- Basic concepts of NLP
- Text processing techniques: Tokenization, Stemming, Lemmatization
- Basic applications of NLP: Sentiment analysis, Text classification, Chatbots

5. Introduction to Neural Networks:

- Overview of Neural Networks
- Perceptrons: Basic unit of neural networks
- Introduction to Multi-layer Perceptrons (MLP)
- Simple neural network applications

6. Basic Tools for AI:

- Introduction to Python programming for AI
- Libraries used in AI: NumPy, Pandas, scikit-learn
- Simple data analysis and visualization with Python

7. Ethical Considerations in AI:

- Ethical challenges in AI (e.g., bias in algorithms)
- Privacy and security concerns

- The role of human oversight in AI systems
- The future of AI in society

Course Outcomes:

By the end of this course, students will be able to:

1. Understand Key AI Concepts:
2. Apply Basic AI Problem-Solving Techniques:
3. Understand and Use Basic Machine Learning Techniques:
4. Understand and Apply Basic NLP Techniques:
5. Understand Neural Networks and Their Applications:
6. Work with Python for AI:
7. Recognize Ethical Issues in AI Development:
8. Communicate AI Concepts

Annexure 'E'

Syllabus of Course Data Science & Analytics (New)

Course Code : CSL DC205
Course Title : Data Science & Analytics
L-T-P/S=Credits : 3-0-0
Course Category : Departmental Core course

Course Objectives:

- To introduce fundamental concepts in data science, statistics, and analytics.
- To provide exposure to descriptive and inferential statistics, with a focus on interpretation and applications.
- To impart hands-on experience in data processing and statistical modeling using Python.
- To build a solid foundation for advanced topics like estimation, hypothesis testing, and regression.

Course Outcomes (COs):

After completing the course, students will be able to:

- Understand and apply fundamental statistical concepts used in data science, including sampling, estimation, and hypothesis testing.
- Summarize, explore, and visualize data effectively using Python libraries.
- Interpret results from basic statistical analyses and machine learning models.
- Implement simple regression and classification techniques for real-world datasets.

Course Content:

Unit 1: Introduction to Data Science and Analytics

- What is Data Science?
- Overview of data science workflow
- Structured vs. unstructured data
- Role of statistics in data science
- Real-life applications in business, healthcare, social media

Unit 2: Python for Data Science Essentials

- Pandas for Data Handling: Series, DataFrames, loading and saving CSV files, filtering, grouping, merging datasets
- Basic Data Cleaning Techniques: Handling missing values, type conversion, renaming columns, detecting duplicates

Unit 3: Descriptive Statistics and Data Visualization

- NumPy for Numerical Computation: Arrays, vectorized operations
- Measures of central tendency (mean, median, mode)
- Measures of dispersion (range, variance, standard deviation)
- Ordered statistics: Minimum, Maximum, and Sample Range
- Data visualization using Python: Matplotlib&Seaborn for Visualizaation: Creating bar charts, histograms,scatter plots, boxplots

Unit 4: Probability & Sampling Distributions

- Basic probabilbability concepts and random variables
- Sampling techniques (random, stratified)
- Concept of sampling distribution of sample mean
- Overview of important distributions: Normal, Binomial, Poisson
- Introduction to Chi-square, t, and F-distributions (with visualization and usage scenarios)

Unit 5: Point & Interval Estimation

- Concept of estimators: bias, consistency, mean squared error
- Method of Moments and introduction to Maximum Likelihood Estimation (MLE)
- Confidence intervals for mean and proportion
- Sample size determination and confidence level
- Brief introduction to pivotal quantities and coverage probabilities (without derivation)

Unit 6: Testing of Hypotheses

- Null and alternative hypotheses, Type I & II errors
- Level of significance, p-values, power (conceptual)
- One-sample and two-sample t-tests (including paired and pooled), chi-square test for independence
- Overview of Neyman-Pearson Lemma (conceptual)
- Introduction to duality between confidence intervals and hypothesis testing

Unit 7: Basics of Predictive Analytics and ANOVA

- Simple Linear Regression (SLR): estimation and interpretation
- Residuals and goodness of fit (R^2, MSE)
- Basics of k-NN classification
- One-way ANOVA: F-test for comparing multiple means (application-level)
- Introduction to Scikit-learn: Splitting data into training/testing sets, applying simple models like Linear Regression and k-NN for prediction

Suggested Textbooks & References:

1. Data Science from scratch – Joel Grus (O'Reilly)
2. Practical Statistics for Data Scientists – Peter Bruce, Andrew Bruce & Peter Gedeck
3. Introduction to Data Science a Python approach to concepts, Techniques and Applications, Igual, L:Seghi', S. Springer, ISBN:978-3-319-50016-4
4. Data Analysis with Python A Modern Approach, David Taieb, Packt Publishing, ISBN-9781789950069
5. Python Data Analysis, Second Ed., Armando Fandango, Packt Publishing, ISBN: 9781787127487
6. Online Resources: Kaggle Datasets, UCI Repository

Course Code	**: CSP DC205**
Course Title	**: Data Science & Analytics Lab**
L-T-P/S=Credits	: 0-0-2 =1
Course Category	: Departmental Core course
Pre-requisite Courses (if any)	:
Equal Course Code (if any)	:
Equivalent Course Code (if any)	:

1. Working with arrays and dataframes using NumPy.
2. Pandas for Data Handling: DataFrames, loading and saving CSV files, filtering, grouping, merging datasets
3. Exploring numerical and categorical data using descriptive statistics.
4. Data cleaning and preprocessing techniques including handling missing values.
5. Visualizing data using basic charts and plots (bar, line, histogram, boxplot).
6. Understanding and simulating common probability distributions.
7. Performing basic sampling and computing sample statistics.
8. Constructing confidence intervals and interpreting them.
9. Hypothesis testing for means, proportions, and variances.
10. Introduction to correlation and simple linear regression.
11. Fitting and evaluating multiple regression models.
12. Applying classification models and interpreting results.
13. Performing Exploratory Data Analysis (EDA) on real-world datasets.
14. Mini project: Apply the complete data analysis pipeline on a selected dataset.

Syllabus of Course Data Science & Analytics (Old)

Course Title: **Data Science & Analytics**

Course Code: CSL DC 205

L-T-P: 3-0-0

Credits: 3

Course Contents

Ordered Statistics, probability distributions of Sample Range, Minimum and Maximum order Statistics. Random Sampling, Sampling distributions: Chi-square, T, F distributions.
Point Estimation: Sufficiency, Factorization theorem, Consistency, Moment method of estimation, Unbiased Estimation, Minimum Variance Unbiased Estimator and their properties, Rao-Cramer lower bound, Rao-Blackwellization, Fisher Information, Maximum Likelihood Estimator and properties, Criteria for evaluating estimators: Mean squared error.
Interval Estimation: Coverage Probabilities, Confidence level, Sample size determination, Shortest Length interval, Pivotal quantities, interval estimators for various distributions.
Testing of Hypotheses: Null and Alternative Hypotheses, Simple hypothesis, Composite hypothesis, Test Statistic, Critical region, Error Probabilities, Power Function, Level of Significance, Neyman-Pearson Lemma, One and Two Sided Tests for Mean, Variance and Proportions, One and Two Sample T-Test, Pooled T-Test, Paired T-Test, Chi-Square Test, Contingency Table Test, Maximum Likelihood Test, Duality between Confidence Intervals.
Bayesian Estimation: Prior and Posterior Distributions, Quadratic Loss Function, Posterior Mean, Bayes Estimates for well Known Distributions (Normal, Gamma, Exponential, Binomial, Poisson, Beta etc.)

Regression & ANOVA Regression ANOVA(Analysis of Variance)

Course Outcomes:

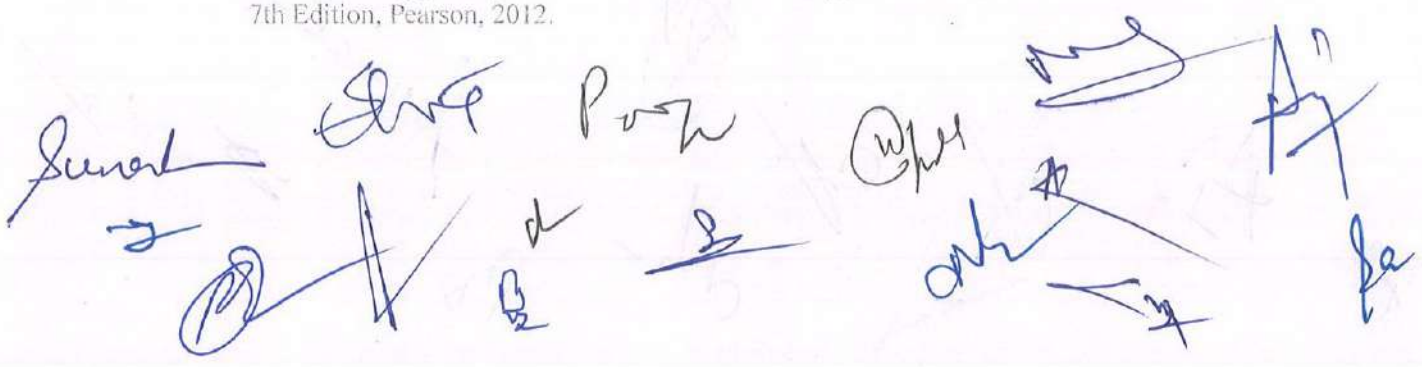
CO1: Apply statistical estimation and hypothesis testing methods to real-world datasets.

CO2: Use appropriate statistical software tools to perform estimations and hypothesis testing.

CO3: Understand a wide range of data analytic techniques around different types of data analytics, namely, descriptive, inferential, predictive, and prescriptive analytics.

Suggested Books:

1. Kandethody M. Ramachandran, Chris P. Tsokos, Mathematical Statistics with applications, Academic Press, 2009.
2. William W. Hines, Douglas C. Montgomery, David M. Goldsman, Connie M. Borror, Probability and Statistics in Engineering, 4th Edition, John Wiley & Sons, 2003.
3. Robert V. Hogg, Joseph W. McKean, Allen T. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson, 2012.



Annexure 'F'

Syllabus of Course High Performance Computing (New)

Course Code	: CSL DE320
Course Title	: High Performance Computing
L-T-P/S=Credits	: 3-1-0
Course Category	: Departmental Elective course
Pre-requisite Courses (if any)	:
Equal Course Code (if any)	:
Equivalent Course Code (if any)	:

Unit-I:
Sequential model, need of alternative model, parallel computational models such as PRAM, LMCC, Hypercube, Cube Connected Cycle, Butterfly, Perfect Shuffle Computers, Tree model, Pyramid model, Fully Connected model, PRAM-CREW, EREW models, simulation of one model from another one.

Unit-II:
Performance Measures of Parallel Algorithms, speed-up and efficiency of PA, Costoptimality, An example of illustrate Cost-optimal algorithms- such as summation, Min/Max on various models.

Unit-III:
Parallel Sorting Networks, Parallel Merging Algorithms on CREW/EREW/MCC/, Parallel Sorting Networks on CREW/EREW/MCC/, linear array

Unit-IV:
Parallel Searching Algorithm, Kth element, Kth element in X+Y on PRAM, Parallel Matrix Transportation and Multiplication Algorithm on PRAM, MCC, Vector-Matrix Multiplication, Solution of Linear Equation, Root finding.

Unit-V:
Graph Algorithms - Connected Graphs, search and traversal, Combinatorial Algorithms- Permutation, Combinations, Derrangements.

Books:
1. M.J. Quinn, "Designing Efficient Algorithms for Parallel Computer" by Mc Graw Hill.
2. S.G. Akl, "Design and Analysis of Parallel Algorithms"
3. S.G. Akl, "Parallel Sorting Algorithm" by Academic Press

Course Outcomes
CO1: Demonstrate understanding of the HPC laws, models and architectures.
CO2: Explain how algorithms can be parallelized.
CO3: Apply concepts and techniques of programming shared-memory multi-core and cluster computers.
CO4: Build and evaluate framework-based systems that utilize hybrid shared/distributed memory computer clusters.

Syllabus of Course High Performance Computing (Old)

High Performance Computing

Prerequisites: Computer Organization and Architecture or equivalent

Course Outcomes
CO1: Demonstrate understanding of the HPC laws, models and architectures.
CO2: Explain how algorithms can be parallelized.
CO3: Apply concepts and techniques of programming shared-memory multi-core and cluster computers.
CO4: Build and evaluate framework-based systems that utilize hybrid shared/distributed memory computer clusters.

Syllabus: Parallel Processing Concepts; Levels and model of parallelism: instruction, transaction, task, thread, memory, function, data flow models, demand-driven computation; Parallel architectures: superscalar architectures, multi-core, multi-threaded, server and cloud;
Fundamental design issues in HPC: Load balancing, scheduling, synchronization and resource management; Operating systems for scalable HPC; Parallel languages and programming environments; OpenMP, Pthread, MPI, java, Cilk; Performance analysis of parallel algorithms;
Fundamental limitations in HPC: bandwidth, latency and latency hiding techniques; Benchmarking HPC: scientific, engineering, commercial applications and workloads; Scalable storage systems: RAID, SSD cache, SAS, SAN; HPC based on cluster, cloud, and grid computing: economic model, infrastructure, platform, computation as service; Accelerated HPC: architecture, programming and typical accelerated system with GPU, FPGA, Xeon Phi, Cell BE; Power-aware
HPC Design: computing and communication, processing, memory design, interconnect design, power management; Advanced topics: peta scale computing; big data processing, optics in HPC, quantum computers.

HPC programming assignments: Hands on experiment and programming on parallel machine and HPC cluster using Pthread, OpenMP, MPI, Nvidia Cuda and Cilk. Also there will be some hands on experiments on standard multiprocessor simulator or cloud simulator.
Texts:
1.Georg Hager and Gerhard Wellein. Introduction to High Performance Computing for Scientists and Engineers (1st ed.). CRC Press, Chapman & Hall/CRC Computational Science, India, 2010.
2. Vipin Kumar , Ananth Grama , Anshul Gupta , George Karypis. Introduction to Parallel Computing (2nd ed.). Pearson India . 2003.
3. John L. Hennessy and David A. Patterson. Computer Architecture: A Quantitative Approach (5th ed.). Elsevier India Pvt. Ltd. 2011.
4. David B. Kirk and Wen-mei W. Hwu. Programming Massively Parallel Processors: A Hands-On Approach (1st ed.). Elsevier India Pvt. Ltd. 2010.
5. Michael T. Heath. Scientific Computing: An Introductory Survey (2nd ed.). McGraw Hill Education (India) Private Limited, 2011

Annexure 'G'

ix) Research Project and Entrepreneurship and venture development to be offered as Elective Courses

To promote research, innovation, and entrepreneurship among undergraduate students (both engineering and Non-engineering) two different tracks in elective courses will be offered as

(a) Undergraduate Research Project
(b) Entrepreneurship and venture development.

(a) Undergraduate Research Project (4.0 Credits)

A Student may register for the undergraduate Research Project of 04 credits as an Elective Course in the Fifth Semester against a DEC/GEC. This course aims to develop analytical skills and critical thinking among the students. The outcome of the research would be considered for the award of credits based upon published work in journals as per details in the Guidelines at X.

(b) Entrepreneurship and venture development (4.0 Credits)

The aim of the entrepreneurship and venture development track is to help students develop entrepreneurial skills and encourage the startup culture in the University. Students may register for this elective in the fifth semester against a DEC/GEC.

X Procedure for Conduct and Evaluation of Undergraduate Research Project

Course objective:

The idea of the course is to develop analytical skills and critical thinking among the students. The course will enable the student to learn appropriate research methodologies and to use them. The course will enable the student to develop a new idea. Further it will allow the student to understand, apply, interpret and evaluate the research concepts. To summarize, the research experience at the undergraduate level will not only allow the student to learn content, but they will also learn how knowledge is constructed in a particular discipline.

The aim of the course is to promote and recognize published research work at the undergraduate level. Hence, the outcome of the course will be a publication in a reputed journal.

a) Course Content

The requirement of this course is to conduct original research. The ideas must be relevant, thoroughly analyzed and empirically validated using quantitative, descriptive, correlational, comparative, quasi-theoretical, and experimental techniques.

It may comprise of creative and meticulous work undertaken to contribute to the state of knowledge, including knowledge of universal, biological, societal systems, and the use of valid stock of knowledge to devise new applications. It may be used to establish or confirm facts, reaffirm the results of previous work, solve new or existing problems, support theorems, or develop new theories.

The outcome of the research would be considered for the award of credits based upon a published work in the reputed journals as listed within the duration of the curriculum.

b) Prerequisites

The student must have obtained a minimum 6.0 CGPA at the end of the fourth semester.

The faculty advisor/s must each have at least 2 SCI/SCI-Expanded/Scopus/ABDC/SSCI publications.

c) Course Details and Publication Acceptance Criteria:

The course will be offered to the students in the 5th semester. The students will be allowed to earn 4 credits by publishing the paper in the third and/or fourth year of B.Tech. program provided:

i) The research work is published in one of the journals listed in the category of premier or commendable research as detailed in point 4;

ii) The faculty advisor is a co-author and the number of student authors is not more than two. Further, there cannot be any other co-authors from outside the university apart from the faculty advisor in the publication.

--- In the case of interdisciplinary/multidisciplinary (interschool/intraschool) research the maximum number of faculty advisors from the university shall not be more than two.

d) Categories of Publication:

The papers published only in SCI/SCI-Expanded/Scopus/ABDC/SSCI journals will be considered for the award of grades and any publications in the predatory journals will not be considered for the award of grades.

e) Process of Registration and Award of Grades

i) The student will be required to register for the course at the beginning of the fifth semester along with the name/s of the faculty advisor/s and consent letter from the faculty advisor/s.

ii) The credits can be earned by the student in subsequent semesters (VI-VIII) when the student provides evidence, through the faculty advisor and HOD, of the online publication of the research paper. *For, instance, if the student provides evidence of the online publication in semester 5th, 4 credits will be awarded to the student in semester 6th. However, in case the publication is made in the semester 8th, the student will be awarded credits in the same semester.*

iii) The following grades will be awarded to the students based on the category of the publication:

Publication Category	Grade
Publication in SCI/SCI-Expanded/Scopus/ABDC/SSCI Premier/Commendable Research category with impact factor >=1	A+
Publication in SCI/SCI-Expanded/Scopus/ABDC/SSCI Premier/Commendable Research category with impact factor between 0.1 to 0.99	A
Publication in SCI/SCI-Expanded/Scopus/ABDC/SSCI Premier/Commendable Research category without impact factor	B+

Comment [sR1]: Looks incomplete

iv) In case a student wants to withdraw from this course then he will have to earn 04 credits by registering in an alternative School elective course/Generic elective course.

v) If a student has not registered for this research course in the 5th semester but can meet all other requirements for earning the credits from the UG research project course then he/she may be allowed to replace his grade and credits earned from some other elective course with grade and credits earned from UG research project (as per Guidelines mentioned above at X)

XI) Procedure of Conduct and Evaluation of Entrepreneurship and Venture Development

Course Objective:

The Entrepreneurship track aims to help students to build up entrepreneurial skills and encourage the startup culture in the University. The students who opt for the entrepreneurship program will be required to produce credible evidence of establishing an enterprise/startup that has been conceptualized and started operation.

a) Course Content

This course requires conceptualizing a business idea and developing the idea into the form of a Start-up/Enterprise/ Venture which comes into operation at the end of the course with credible evidence of operation.

The outcome of the Entrepreneurship course would be considered for the award of credits based upon the credible evidence of the operation of the start-up.

b) Course Registration

i) The Entrepreneurship option will be offered to the Students in the V semester as part of School/Generic elective courses.

ii) The duration of the course shall be 1-2 years. The examination for the course will be conducted at the end of the VI to VIII semester.

iii) A maximum of four Students can register for this elective out of which not more than two should be from the specific school.

c) Procedure of Conduct and Evaluation

i) The registered student/team must submit a proposal detailing the enterprise being set up including innovative idea generation, planning, organizing, financing, and marketing strategies of the proposed plan in the academic section within 10 days of registration, in the prescribed format. (Formats are enclosed)

ii) An evaluation committee, comprising of (i) Chairperson(s) BOS of the respective department of the student/team (ii) Two faculty members, and (iii) an External expert; nominated by the Vice chancellor will approve/reject proposals based on the merits and expected outcome of the proposals. The same committee may also assign the maximum possible grades for an approved proposal.

iii) The duration of the course shall be 1-2 years. The evaluation for the course shall be conducted at the end of the VI to VIII semester.

iv) The evaluation of the course will be based on mid-term and end-term examinations with a weightage of 40% and 60% respectively.

v) The mid-term evaluation will be held at the end of each semester till the proposal approaches its outcome. The mid-term evaluation will be based on progress reports submitted and presentation at the end of every semester, before final submission.

vi) The end-term examination will be carried out at the end of the VI to VIII semester and not later than 10 days from the last theory paper examination. The examination will be

conducted by the same committee which approved the proposal. However, in case of non-availability of any of the members, the Vice Chancellor may nominate other examiners.

vii) The student/team shall be required to submit a final detailed project report (DPR) at least 3 days before the scheduled date of end semester examination for this course.

viii) The final evaluation will be based on the proposal outcome, report quality, presentation, and viva voce.

ix) An absolute grading system will be used for the course. The Grade Moderation Committee for the course will be the same as that for other courses of the class.

x) In case a student/team is awarded a failing grade in the course student/team shall have to repeat the course either in the form of a new project or register in some other School/generic elective course having equivalent credits as per their choice.

xi) In case a student/team wants to drop this course the student/team shall have to register in some other School/generic elective course having equivalent credits.

xii) Normal attendance regulations will not apply to this course.

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering
Faculty of Engineering, SMVDU
Kakryal, Katra 182320

Annexure 'H'

Proposed Course Structure for

Bachelor of Technology in Computer Science & Engineering

as per AICTE (NEP) Guidelines

[Entry Batch 2024 Onwards]

Semester 1

Category	Course Code	Course Title	L	T	P	C
BSC 1	MTL BS101	Engineering Mathematics-I	3	1	0	4
ESC 1	ECL ES103	Digital Electronics	3	0	0	3
ESC 1	ECP ES103	Digital Electronics Lab	0	0	2	1
BSC 2	PHL BS101	Engineering Physics	3	0	0	3
BSC 2	PHP BS101	Engineering Physics Lab	0	0	2	1
ESC 2	CSL ES101	Introduction to C Programming	3	0	0	3
ESC 2	CSP ES101	C Programming Lab	0	0	2	1
SEC 1	MEM SE103	Engineering Graphics with CAD	1	0	2	2
AEC 1 /VAC 1		Ability Enhancement Course-1 / Value Added Course-1	2	0	0	2
	Total Credits		15	1	8	**20**

Semester 2

Category	Course Code	Course Title	L	T	P	C
BSC 3	MTL BS102	Engineering Mathematics-II	3	1	0	4
BSC 4	MTL BS106	Discrete Structures	3	1	0	4
DCC 1	CSL DC102	Programming using Python	3	0	0	3
DCC 1	CSP DC102	Python Programming Lab	0	0	2	1
DCC 2	CSL DC104	Data structure	3	0	0	3
DCC 2	CSP DC104	Data Structure Lab	0	0	2	1
SEC 2	MEM SE104	Engineering Workshop	1	0	2	2
AEC 2		Ability Enhancement Course-2	2	0	0	2
VAC 2		Value Added Course-2	2	0	0	2
MAC 1	PCL MA102	Universal Human Values - II	2	0	0	NC
		Total Credits	17	2	6	22
	Total Credits Earned at the end of 1st Year					42

At this stage, the student has the following two options:

a) **Exit option:** Students who opt to exit after completion of the first year and have secured 42 credits (As per the program structure) will be awarded a UG certificate if, in addition, **they earn an additional 6 credits through 8 weeks summer internship/ ITI level courses/skill-based courses** during the summer vacation of the first year.

b) Continue to the 2nd Year of the program (Subject to meeting the promotion criteria)

Semester 3

Category	Course Code	Course Title	L	T	P	C
VAC 3		Value Added Course-3	2	0	0	2
DCC 3	CSL DC201	Theory of Computation	3	1	0	4
SEC 3		Skill Enhancement Course-3	2	0	0	2
BSC 5	BTL BS201	Introduction to Biology for Engineers	3	0	0	3
DCC 4	CSL DC203	Operating Systems	3	0	0	3
DCC 4	CSP DC203	Operating Systems Lab	0	0	2	1
ESC 3	ECL ES205	Microprocessors & Interfacing	3	0	0	3
ESC 3	ECP ES205	Microprocessors & Interfacing Lab	0	0	2	1
PR	CSI PR201	Summer Internship-I	0	0	2	1
DCC 5	CSL DC205	Data Science & Analytics	3	0	0	3
DCC 5	CSP DC205	Data Science & Analytics Lab	0	0	2	1
		Total Credits	19	1	8	24

Semester 4

Category	Course Code	Course Title	L	T	P	C
VAC 4		Value Added Course-4	2	0	0	2
DCC 6	CSL DC202	Soft Computing	3	0	0	3
DCC 6	CSP DC202	Soft Computing Lab	0	0	2	1
DCC 7	CSL DC204	Design & Algorithm Analysis	3	0	0	3
DCC 7	CSP DC204	Design & Algorithm Analysis Lab	0	0	2	1
DCC 8	CSL DC206	Database Management Systems	3	0	0	3
DCC 8	CSP DC206	Database Management Systems Lab	0	0	2	1
DCC 9	CSL DC208	Computer Organization & Architecture	3	1	0	4
DCC 10	CSL DC210	Compiler Design	3	1	0	4
		Total Credits	19	2	6	22
	Total Credits Earned at the end of 2nd Year					88

At this stage, the student has the following two options:

1. Exit option: Students who opt to exit after completion of the second year and have secured 88 credits (As per the program structure) shall be awarded the UG Diploma if, in addition, they earn an additional 6 credits through 8 weeks of summer internship/ Diploma level courses/skill-based courses during the summer vacation of the second year.

2. Continue to the 3rd Year of the program (Subject to meeting promotion criteria) and
   a. Declare their choice of obtaining an Honours degree and choose the Specialization
   b. Declare their choice of obtaining a Minor Specialization and choose the Minor Specialization
   c. Choose not to opt for any of the above two options

Semester 5

Category	Course Code	Course Title	L	T	P	C
DEC 1	CSL DE3XX	School Elective – I	3	0/1	0/2	4
DEC 2 / GEC 1	CSL DE3XX / CSL GE3XX	School Elective – II/Generic Elective -I	3	0/1	0/2	4
DCC 11	CSL DC301	Computer Networks & Communication	3	0	0	3
DCC 11	CSP DC301	Computer Networks & Communication Lab	0	0	2	1
DCC 12	CSL DC303	Object Oriented Programming using JAVA	3	0	0	3
DCC 12	CSP DC303	Object Oriented Programming Lab using JAVA	0	0	2	1
DCC 13	CSL DC305	Machine Learning	3	0	0	3
DCC 13	CSP DC305	Machine Learning Lab	0	0	2	1
PR	CSI PR301	Summer Internship-II	0	0	2	1
PR	CSD PR301	Project Work – I	0	0	4	2
	Total Credits		17	0	12	23
DEC/GEC (Additional)		For earning Honors/ Minor Specialization				4*

Semester 6

Category	Course Code	Course Title	L	T	P	C
DEC-3	CSL DE3XX	School Elective – III	3	0/1	0/2	4
DEC-4 /GEC-2	CSL DE3XX / CSL GE3XX	School Elective – IV/Generic Elective –II	3	0/1	0/2	4
AEC (compulsory)		Management Course/ Entrepreneurship/Economy	3	0	0	3
DCC 14	CSL DC302	Deep Learning	3	0	0	3
DCC 14	CSP DC302	Deep Learning Lab	0	0	2	1
DCC 15	CSL DC304	Software Engineering	3	0	0	3
DCC 15	CSP DC304	Software Engineering Lab	0	0	2	1
PR	CSD PR302	Project Work - II	0	0	4	2
MAC 2		Indian Knowledge System	2	0	0	NC
	Total Credits		19	0	8	21
	Total Credits Earned at the end of 3rd Year					132
DEC/GEC (Additional)		For earning Honors/ Minor Specialization				4*

At this stage, the student has the following three options:

1. **Exit option:** Students who opt to exit after completion of the third year and have secured 132 credits (As per the program structure) shall be awarded a B.VOC Degree in the Major discipline if, in addition, **they have completed a summer internship of additional 4 credits during the 8 weeks of the summer vacations** of the third year.

2. Continue to the 4th Year of the program (Subject to meeting promotion criteria)

Semester 7

Category	Course Code	Course Title	L	T	P	C
PR	CSD PR401	Project Work– III	0	0	8	4
PR	CSI PR401	Summer Internship - III	0	0	4	2
DEC-5	CSL DE4XX	School Elective – V	3	0/1	0/2	4
DEC-6 / GEC-3	CSL DE4XX / CSL GE4XX	School Elective – VI/ Generic Elective – III	3	0/1	0/2	4
DCC 16	CSL DC401	Digital Image Processing	3	0	0	3
DCC 16	CSP DC401	Digital Image Processing Lab	0	0	2	1
		Total Credits	11	0	14	**18**
DEC/GEC (Additional)		For earning Honors/ Minor Specialization				4*

*Internship to be completed in summer vacation after sixth semester.

Semester 8

Category	Course Code	Course Title	L	T	P	C
PR	CSD PR402 / CSI PR402	Major Project / Internship (Industrial or In-house Project)				10
		Total Credits				10
	Total Credits Earned at the end of 4th Year					160
DEC/GEC (Additional)		For earning Honors/ Minor Specialization				4*

Note:

i. One of the Discipline Core Courses (DCC) will necessarily be a Discipline Specific Course in AI/ ML worth 4 Credits.
ii. It is mandatory for every student of the B.Tech. program to take one course on Environmental Science

Award of Degree:

A) **B.Tech. degree:** Students who successfully earn the 160 credits (as per the program structure) and have not opted for Honors/Minor specialization will be awarded the B.Tech. degree in the discipline subject to their meeting all other requirements for the award of degree.

B) **B.Tech. degree with Honors (Discipline specific Specialization):** Students who have opted for an Honors degree (Specialization within the discipline) will be awarded the B.Tech. degree with Honors (subject to their meeting all other requirements), if they have pass a total of 06 courses (Earn 24 credits) from the basket of courses corresponding to the specialization and earn a total of 172 credits to be eligible for the award of the Honors degree.

C) **B.Tech. degree with Minor Specialization (Specialization from other Disciplines):** Students will be awarded the B.Tech. degree with Minor Specialization, if they have pass a total of 06 courses (Earn 24 credits) from the basket of courses corresponding to the specialization and earn a total of 172 credits to be eligible for the award of the Minor Specialization.

LIST OF SCHOOL ELECTIVE COURSES

Two new **School Elective courses proposed w.e.f entry batch 2024:** To promote research, innovation, and entrepreneurship among undergraduate students (both engineering and Non-engineering) two different tracks in elective courses will be offered as

i. Undergraduate Research Project (4 credits)
ii. Entrepreneurship and Venture Development (4 credits)

S.No.	Course Code	Course Title	L	T	P	C
		School Elective I / DEC–I				
1	CSM DE301	Software Defined Networks	3	0	2	4
2	CSL DE303	Storage Networks (SE)	3	1	0	4
3	CSL DE305	Computer Vision	3	1	0	4
4	CSM DE307	Web Programming	3	0	2	4
5	CSL DE309	Block Chain Technology	3	1	0	4
6	CSM DE311	Data Visualization (Hon. DS &AI)	3	0	2	4
		School Elective II /DEC–II				
1	CSL DE313	Probability & Stochastic Processes (Hon. DS &AI)	3	1	0	4
2	CSL DE315	Cloud Computing	3	1	0	4
3	CSL DE317	Parallel & Distributed Computing	3	1	0	4
4	CSL DE319	Advanced Mobile Communication using 5G	3	1	0	4
5	CSL DE325	Advanced Computer Architecture	3	1	0	4
6	CSM DE323	Computer Network Security (SE)	3	0	2	4
7	CSR DE301	Undergraduate Research Project				4
8	CSD DE301	Entrepreneurship and Venture Development				4
		School Elective III /DEC– III				
1	CSM DE302	Data Mining & Warehousing (Hon. DS &AI)	3	0	2	4
2	CSL DE304	Human Computer Interaction	3	1	0	4
3	CSM DE306	Quantum Computing	3	0	2	4
4	CSL DE308	Mobile & App Development	3	1	0	4
		School Elective IV /DEC–IV				
1	CSM DE322	Digital Twin (Hon. DS &AI)	3	0	2	4
2	CSM DE310	Internet of Things (Hon. DS &AI)	3	0	2	4
3	CSM DE312	Wireless Networks	3	0	2	4
4	CSL DE314	Information Coding Practices	3	1	0	4
5	CSL DE316	Computer Embedded Systems	3	1	0	4
6	CSL DE318	Multimedia and Virtual Reality	3	1	0	4
7	CSL DE320	High Performance Computing	3	1	0	4
		School Elective V /DEC–V				
1	CSL DE401	Nature Inspired Algorithms (Hon. DS &AI)	3	1	0	4
2	CSL DE411	Robotics & Vision Control (Hon. DS &AI)	3	1	0	4
3	CSL DE403	Metaheuristic Design Framework	3	1	0	4
4	CSL DE405	Cyber Security	3	1	0	4
5	CSL DE407	E-Commerce & Cyber Laws	3	1	0	4
6	CSL DE409	Digital Forensic	3	1	0	4
		School Elective VI /DEC–VI				
1	CSLDE413	Natural Language Processing (Hon. DS &AI)	3	1	0	4
2	CSL DE415	Foundation Models (Hon. DS &AI)	3	1	0	4

Four Year B.Tech. Degree with/without Honors or with/without Minor Specialization

B.Tech. degree with Honors (Discipline specific Specialization): Students who have opted for an Honors degree (Specialization within the discipline) will be awarded the B.Tech. degree with Honors (subject to their meeting all other requirements), **if they have successfully earned 172 Credits, out of which 24 credits must have been earned through the basket of the specified specialization and 12 credits from the general basket of (Departmental Elective Courses-DEC).**

The list of Department Elective Courses offered under Honors degree namely-

i) **B.Tech. CSE Honors in Data Science & Artificial Intelligence**

Course Type	Course Code	Course Title	L	T	P/S	Credits
DEC I	CSM DE311	Data Visualization	3	0	2	4
DEC II	CSL DE313	Probability & Stochastic Processes	3	1	0	4
DEC III	CSM DE302	Data Mining & Warehousing	3	0	2	4
DEC IV	CSM DE322	Digital Twin	3	0	2	4
DEC IV	CSM DE310	Internet of Things	3	0	2	4
DEC V	CSL DE401	Nature Inspired Algorithms	3	1	0	4
DEC V	CSL DE411	Robotics & Vision Control	3	1	0	4
DEC VI	CSL DE413	Natural Language Processing	3	1	0	4
DEC VI	CSL DE415	Foundation Models	3	1	0	4
DEC (Addl)	CSL DE315	Cloud Computing	3	1	0	4
DEC (Addl)	CSL DE320	High Performance Computing	3	1	0	4
DEC (Addl)	CSM DE321	Business Analytics with R	3	0	2	4

The students interested in obtaining a B.Tech. degree with Honors (Discipline specific Specialization), towards the end of the 4th semester, shall have to declare their chosen Specialization out of the list of specializations offered by their School in the form of a list of courses (Departmental Elective Courses-DEC).

They are required to pass a total of 06 courses (Earn 24 credits) from the basket of courses corresponding to the specialization and earn a total of 172 credits to be eligible for the award of the Honors degree.

The 06 courses for obtaining Honors can be undertaken in offline mode in class or through MOOC-SWAYAM or other modes of credit transfer (See rules for Credit Transfer) subject to the student having obtained prior permission from the Head of the School.

Four Year B.Tech. Degree with/without Honors or with/without Minor Specialization

B.Tech. degree with Minor Specialization (Specialization from other Disciplines): Students who had opted for a Minor Specialization (Specialization from other disciplines) will be awarded the B.Tech. degree with Minor Specialization, if they have successfully earned 172 Credits, out of which 24 credits must have been earned through the basket of the Minor specialization (GEC category courses).

The list of Generic Elective Courses offered under two minor specializations namely-

a) **Minor Specialization in Artificial Intelligence**
b) **Minor Specialization in Information Security**

Minor Specialization in Artificial Intelligence					
Course Code	Course Title	L	T	P	Credits
CSL GE301	Introduction to Artificial Intelligence	3	1	0	4
CSL GE305	Probability & Statistics	3	1	0	4
CSM GE302	Introduction to Machine Learning	3	0	2	4
CSM GE306	Data Analytics	3	0	2	4
CSM GE401	Soft Computing	3	0	2	4
CSL GE405	Natural Language Processing	3	1	0	4
CSL GE402	Artificial Intelligence for Engineering Applications	3	1	0	4
CSL GE406	Prompt Engineering	3	1	0	4
CSL GE410	Vision Transformers	3	1	0	4

Minor Specialization in Information Security					
Course Code	Course Title	L	T	P	Credits
CSM GE303	Computer Network & Communication	3	0	2	4
CSL GE307	Information & Coding Practices	3	1	0	4
CSM GE304	Wireless Networks	3	0	2	4
CSM GE308	Internet of Things	3	0	2	4
CSL GE403	Introduction to Cyber Security	3	1	0	4
CSL GE407	Block Chain Coding	3	1	0	4
CSL GE404	Privacy & Security in Online Social Media	3	1	0	4
CSL GE408	Information Response & Management	3	1	0	4

The student interested in obtaining a B.Tech. degree with a Minor Specialization (Specialization from another discipline), towards the end of the 4th semester, shall have to declare their chosen Specialization out of the list of specializations offered by the other Schools in the form of a list of courses (Generic Elective Courses-GEC).

They are required to pass a total of 06 courses (Earn 24 credits) from the basket of courses corresponding to the specialization and earn a total of 172 credits to be eligible for the award of the Minor Specialization.

The 06 courses for obtaining Honors can be undertaken in offline mode in class or through MOOC-SWAYAM or other modes of credit transfer (See rules for Credit Transfer) subject to the student having obtained prior permission from the Head of the School.

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

Shri Mata Vaishno Devi University

School of Computer Science and Engineering

Faculty of Engineering, SMVDU

Kakryal, Katra 182320

Annexure 'I'

Proposed Course Structure for

Bachelor of Technology in Computer Science & Engineering

as per AICTE (NEP) Guidelines

[Entry Batch 2023]

Semester 1

Category	Course Code	Course Title	L	T	P	C
BSC 1	MTL BS101	Engineering Mathematics-I	3	1	0	4
ESC 1	ECL ES103	Digital Electronics	3	0	0	3
ESC 1	ECP ES103	Digital Electronics Lab	0	0	2	1
BSC 2	PHL BS101	Engineering Physics	3	0	0	3
BSC 2	PHP BS101	Engineering Physics Lab	0	0	2	1
ESC 2	CSL ES101	Introduction to C Programming	3	0	0	3
ESC 2	CSP ES101	C Programming Lab	0	0	2	1
SEC 1	MEM SE103	Engineering Graphics with CAD (Skill Enhancement Course-1)	1	0	2	2
AEC 1 /VAC 1		Ability Enhancement Course-1 / Value Added Course-1	2	0	0	2
	Total Credits		15	1	8	20

Semester 2

Category	Course Code	Course Title	L	T	P	C
BSC 3	MTL BS102	Engineering Mathematics-II	3	1	0	4
BSC 4	BTL BS102	Biology for Engineers	3	1	0	4
DCC 1	CSL DC102	Programming using Python	3	0	0	3
DCC 1	CSP DC102	Python Programming Lab	0	0	2	1
DCC 2	CSL DC104	Data structure	3	0	0	3
DCC 2	CSP DC104	Data Structure Lab	0	0	2	1
SEC 2	MEM SE101	Engineering Workshop	1	0	2	2
AEC 2		Ability Enhancement Course-2	2	0	0	2
VAC 2		Value Added Course-2	2	0	0	2
MAC 1	PCL MA102	Universal Human Values - II	2	0	0	NC
		Total Credits	17	2	6	22
	Total Credits Earned at the end of 1st Year					42

At this stage, the student has the following two options:

a) **Exit option:** Students who opt to exit after completion of the first year and have secured 42 credits (As per the program structure) will be awarded a UG certificate if, in addition, **they earn an additional 6 credits through 8 weeks summer internship/ ITI level courses/skill-based courses** during the summer vacation of the first year.

b) Continue to the 2nd Year of the program (Subject to meeting the promotion criteria)

Semester 3

Category	Course Code	Course Title	L	T	P	C
AEC 3/ VAC 3	BTL VA202	Environmental Science & Education	2	0	0	2
DCC 3	CSL DC201	Theory of Computation	3	1	0	4
SEC 3	CSL SE201	Artificial Intelligence: Constraint Satisfaction Problems	2	0	0	2
BSC 5	MTL BS201	Discrete Structures	3	0	0	3
DCC 4	CSL DC203	Operating Systems	3	0	0	3
DCC 4	CSP DC203	Operating Systems Lab	0	0	2	1
ESC 3	ECL ES205	Microprocessors & Interfacing	3	0	0	3
ESC 3	ECP ES205	Microprocessors & Interfacing Lab	0	0	2	1
PR	CSI PR201	Summer Internship-I	0	0	2	1
DCC 5	CSL DC205	Data Science & Analytics	3	0	0	3
DCC 5	CSP DC205	Data Science & Analytics Lab	0	0	2	1
		Total Credits	19	1	8	24

Semester 4

Category	Course Code	Course Title	L	T	P	C
VAC 4		Value Added Course-4	2	0	0	2
DCC 6	CSL DC202	Soft Computing	3	0	0	3
DCC 6	CSP DC202	Soft Computing Lab	0	0	2	1
DCC 7	CSL DC204	Design & Algorithm Analysis	3	0	0	3
DCC 7	CSP DC204	Design & Algorithm Analysis Lab	0	0	2	1
DCC 8	CSL DC206	Database Management Systems	3	0	0	3
DCC 8	CSP DC206	Database Management Systems Lab	0	0	2	1
DCC 9	CSL DC208	Computer Organization & Architecture	3	1	0	4
DCC 10	CSL DC210	Compiler Design	3	1	0	4
		Total Credits	19	2	6	22
	Total Credits Earned at the end of 2nd Year					88

At this stage, the student has the following two options:

1. **Exit option:** Students who opt to exit after completion of the second year and have secured 88 credits (As per the program structure) shall be awarded the UG Diploma if, in addition, **they earn an additional 6 credits through 8 weeks of summer internship/ Diploma level courses/skill-based** courses during the summer vacation of the second year.

2. Continue to the 3rd Year of the program (Subject to meeting promotion criteria) and
   a. Declare their choice of obtaining an Honours degree and choose the Specialization
   b. Declare their choice of obtaining a Minor Specialization and choose the Minor Specialization
   c. Choose not to opt for any of the above two options

Semester 5

Category	Course Code	Course Title	L	T	P	C
DEC 1	CSL DE3XX	School Elective – I	3	0/1	0/2	4
DEC 2 / GEC 1	CSL DE3XX / CSL GE3XX	School Elective – II/Generic Elective -I	3	0/1	0/2	4
DCC 11	CSL DC301	Computer Networks & Communication	3	0	0	3
DCC 11	CSP DC301	Computer Networks & Communication Lab	0	0	2	1
DCC 12	CSL DC303	Object Oriented Programming using JAVA	3	0	0	3
DCC 12	CSP DC303	Object Oriented Programming Lab using JAVA	0	0	2	1
DCC 13	CSL DC305	Machine Learning	3	0	0	3
DCC 13	CSP DC305	Machine Learning Lab	0	0	2	1
PR	CSI PR301	Summer Internship-II	0	0	2	1
PR	CSD PR301	Project Work – I	0	0	4	2
	Total Credits		17	0	12	23
DEC/GEC (Additional)		For earning Honors/ Minor Specialization				4*

Semester 6

Category	Course Code	Course Title	L	T	P	C
DEC-3	CSL DE3XX	School Elective – III	3	0/1	0/2	4
DEC-4 /GEC-2	CSL DE3XX / CSL GE3XX	School Elective – IV/Generic Elective –II	3	0/1	0/2	4
AEC (compulsory)		Management Course/ Entrepreneurship/Economy	3	0	0	3
DCC 14	CSL DC302	Deep Learning	3	0	0	3
DCC 14	CSP DC302	Deep Learning Lab	0	0	2	1
DCC 15	CSL DC304	Software Engineering	3	0	0	3
DCC 15	CSP DC304	Software Engineering Lab	0	0	2	1
MAC 2		Indian Knowledge System	2	0	0	NC
PR	CSD PR302	Project Work - II	0	0	4	2
	Total Credits		19	0	8	21
	Total Credits Earned at the end of 3rd Year					132
DEC/GEC (Additional)		For earning Honors/ Minor Specialization				4*

At this stage, the student has the following three options:

1. **Exit option:** Students who opt to exit after completion of the third year and have secured 132 credits (As per the program structure) shall be awarded a B.VOC Degree in the Major discipline if, in addition, they have completed a summer internship of additional 4 credits during the 8 weeks of the summer vacations of the third year.

2. Continue to the 4th Year of the program (Subject to meeting promotion criteria)

Semester 7

Category	Course Code	Course Title	L	T	P	C
PR	CSD PR401	Project Work– III	0	0	8	4
PR	CSI PR401	Summer Internship - III	0	0	4	2
DEC-5	CSL DE4XX	School Elective – V	3	0/1	0/2	4
DEC-6 / GEC-3	CSL DE4XX / CSL GE4XX	School Elective – VI/ Generic Elective – III	3	0/1	0/2	4
DCC 16	CSL DC401	Digital Image Processing	3	0	0	3
DCC 16	CSP DC401	Digital Image Processing Lab	0	0	2	1
		Total Credits	11	0	14	**18**
DEC/GEC (Additional)		For earning Honors/ Minor Specialization				4*

*Internship to be completed in summer vacation after sixth semester.

Semester 8

Category	Course Code	Course Title	L	T	P	C
PR	CSD PR402 / CSI PR402	Major Project / Internship (Industrial or In-house Project)				10
		Total Credits				**10**
	Total Credits Earned at the end of 4th Year					**160**
DEC/GEC (Additional)		For earning Honors/ Minor Specialization				4*

Note:

i. One of the Discipline Core Courses (DCC) will necessarily be a Discipline Specific Course in AI/ ML worth 4 Credits.
ii. It is mandatory for every student of the B.Tech. program to take one course on Environmental Science

Award of Degree:

A) **B.Tech. degree:** Students who successfully earn the 160 credits (as per the program structure) and have not opted for Honors/Minor specialization will be awarded the B.Tech. degree in the discipline subject to their meeting all other requirements for the award of degree.

B) **B.Tech. degree with Honors (Discipline specific Specialization):** Students who have opted for an Honors degree (Specialization within the discipline) will be awarded the B.Tech. degree with Honors (subject to their meeting all other requirements), if they have **pass a total of 06 courses (Earn 24 credits) from the basket of courses** corresponding to the specialization and earn a total of 172 credits to be eligible for the award of the Honors degree.

C) **B.Tech. degree with Minor Specialization (Specialization from other Disciplines):** Students will be awarded the B.Tech. degree with Minor Specialization, **if they have pass a total of 06 courses (Earn 24 credits) from the basket of courses** corresponding to the specialization and earn a total of 172 credits to be eligible for the award of the Minor Specialization.

LIST OF SCHOOL ELECTIVE COURSES

S.No.	Course Code	Course Title	L	T	P	C
		School Elective I / DEC–I				
1	CSM DE301	Software Defined Networks	3	0	2	4
2	CSL DE303	Storage Networks (SE)	3	1	0	4
3	CSL DE305	Computer Vision	3	1	0	4
4	CSM DE307	Web Programming	3	0	2	4
5	CSL DE309	Block Chain Technology	3	1	0	4
6	CSM DE311	Data Visualization (Hon. DS &AI)	3	0	2	4
		School Elective II /DEC–II				
1	CSL DE313	Probability & Stochastic Processes (Hon. DS &AI)	3	1	0	4
2	CSL DE315	Cloud Computing	3	1	0	4
3	CSL DE317	Parallel & Distributed Computing	3	1	0	4
4	CSL DE319	Advanced Mobile Communication using 5G	3	1	0	4
5	CSL DE325	Advanced Computer Architecture	3	1	0	4
6	CSM DE323	Computer Network Security (SE)	3	0	2	4
		School Elective III /DEC– III				
1	CSM DE302	Data Mining & Warehousing (Hon. DS &AI)	3	0	2	4
2	CSL DE304	Human Computer Interaction	3	1	0	4
3	CSM DE306	Quantum Computing	3	0	2	4
4	CSL DE308	Mobile & App Development	3	1	0	4
		School Elective IV /DEC–IV				
1	CSM DE322	Digital Twin (Hon. DS &AI)	3	0	2	4
2	CSM DE310	Internet of Things (Hon. DS &AI)	3	0	2	4
3	CSM DE312	Wireless Networks	3	0	2	4
4	CSL DE314	Information Coding Practices	3	1	0	4
5	CSL DE316	Computer Embedded Systems	3	1	0	4
6	CSL DE318	Multimedia and Virtual Reality	3	1	0	4
7	CSL DE320	High Performance Computing	3	1	0	4
		School Elective V /DEC–V				
1	CSL DE401	Nature Inspired Algorithms (Hon. DS &AI)	3	1	0	4
2	CSL DE411	Robotics & Vision Control (Hon. DS &AI)	3	1	0	4
3	CSL DE403	Metaheuristic Design Framework	3	1	0	4
4	CSL DE405	Cyber Security	3	1	0	4
5	CSL DE407	E-Commerce & Cyber Laws	3	1	0	4
6	CSL DE409	Digital Forensic	3	1	0	4
		School Elective VI /DEC–VI				
1	CSLDE413	Natural Language Processing (Hon. DS &AI)	3	1	0	4
2	CSL DE415	Foundation Models (Hon. DS &AI)	3	1	0	4

Four Year B.Tech. Degree with/without Honors or with/without Minor Specialization

B.Tech. degree with Honors (Discipline specific Specialization): Students who have opted for an Honors degree (Specialization within the discipline) will be awarded the B.Tech. degree with Honors (subject to their meeting all other requirements), **if they have successfully earned 172 Credits, out of which 24 credits must have been earned through the basket of the specified specialization and 12 credits from the general basket of (Departmental Elective Courses-DEC).**

The list of Department Elective Courses offered under Honors degree namely-

i) **B.Tech. CSE Honors in Data Science & Artificial Intelligence**

Course Type	Course Code	Course Title	L	T	P	Credits
DEC I	**CSM DE311**	Data Visualization	3	0	2	4
DEC II	CSL DE313	Probability & Stochastic Processes	3	1	0	4
DEC III	**CSM DE302**	Data Mining & Warehousing	3	0	2	4
DEC IV	**CSM DE322**	Digital Twin	3	0	2	4
DEC IV	**CSM DE310**	Internet of Things	3	0	2	4
DEC V	CSL DE401	Nature Inspired Algorithms	3	1	0	4
DEC V	CSL DE411	Robotics & Vision Control	3	1	0	4
DEC VI	CSL DE413	Natural Language Processing	3	1	0	4
DEC VI	CSL DE415	Foundation Models	3	1	0	4
DEC (Addl)	CSL DE315	Cloud Computing	3	1	0	4
DEC (Addl)	CSL DE320	High Performance Computing	3	1	0	4
DEC (Addl)	**CSM DE321**	Business Analytics with R	3	0	2	4

The students interested in obtaining a B.Tech. degree with Honors (Discipline specific Specialization), towards the end of the 4th semester, shall have to declare their chosen Specialization out of the list of specializations offered by their School in the form of a list of courses (Departmental Elective Courses-DEC).

They are required to pass a total of 06 courses (Earn 24 credits) from the basket of courses corresponding to the specialization and earn a total of 172 credits to be eligible for the award of the Honors degree.

The 06 courses for obtaining Honors can be undertaken in offline mode in class or through MOOC-SWAYAM or other modes of credit transfer (See rules for Credit Transfer) subject to the student having obtained prior permission from the Head of the School.

Four Year B.Tech. Degree with/without Honors or with/without Minor Specialization

B.Tech. degree with Minor Specialization (Specialization from other Disciplines): Students who had opted for a Minor Specialization (Specialization from other disciplines) will be awarded the B.Tech. degree with Minor Specialization, if they have successfully earned 172 Credits, out of which 24 credits must have been earned through the basket of the Minor specialization (GEC category courses).

The list of Generic Elective Courses offered under two minor specializations namely-

a) **Minor Specialization in Artificial Intelligence**
b) **Minor Specialization in Information Security**

Minor Specialization in Artificial Intelligence					
Course Code	Course Title	L	T	P	Credits
CSL GE301	Introduction to Artificial Intelligence	3	1	0	4
CSL GE305	Probability & Statistics	3	1	0	4
CSM GE302	Introduction to Machine Learning	3	0	2	4
CSM GE306	Data Analytics	3	0	2	4
CSM GE401	Soft Computing	3	0	2	4
CSL GE405	Natural Language Processing	3	1	0	4
CSL GE402	Artificial Intelligence for Engineering Applications	3	1	0	4
CSL GE406	Prompt Engineering	3	1	0	4
CSL GE410	Vision Transformers	3	1	0	4

Minor Specialization in Information Security					
Course Code	Course Title	L	T	P	Credits
CSM GE303	Computer Network & Communication	3	0	2	4
CSL GE307	Information & Coding Practices	3	1	0	4
CSM GE304	Wireless Networks	3	0	2	4
CSM GE308	Internet of Things	3	0	2	4
CSL GE403	Introduction to Cyber Security	3	1	0	4
CSL GE407	Block Chain Coding	3	1	0	4
CSL GE404	Privacy & Security in Online Social Media	3	1	0	4
CSL GE408	Information Response & Management	3	1	0	4

The student interested in obtaining a B.Tech. degree with a Minor Specialization (Specialization from another discipline), towards the end of the 4th semester, shall have to declare their chosen Specialization out of the list of specializations offered by the other Schools in the form of a list of courses (Generic Elective Courses-GEC).

They are required to pass a total of 06 courses (Earn 24 credits) from the basket of courses corresponding to the specialization and earn a total of 172 credits to be eligible for the award of the Minor Specialization.

The 06 courses for obtaining Honors can be undertaken in offline mode in class or through MOOC-SWAYAM or other modes of credit transfer (See rules for Credit Transfer) subject to the student having obtained prior permission from the Head of the School.

Annexure K

Course Code	**: CSL DE401**
Course Title	**: Nature Inspired Algorithms**
L-T-P/S=Credits	**: 3-1-0**
Course Category	**: Departmental Elective course**
Pre-requisite Courses (if any)	:
Equal Course Code (if any)	:
Equivalent Course Code (if any)	:

Syllabus

Unit I: Introduction to Algorithms

Topic I: What is an algorithm, Newton's method, Gradient Descent Method, Formulation for optimization problems, Optimization algorithms, search for optimality, No-free lunch theorem, Heuristic and Meta-heuristic algorithms, NP Hard and NP Complete Problems

Topic II: Mathematical foundations: Norms, Eigen values, Eigen vectors, Sequences & Series, Convex Optimization – Hessian Matrix, Subgradient Descent, Computational Complexity, Convex Hull- Graham Scan Algorithm, Random Variables & Probability distributions

Unit II: Simulated Annealing

SA: Annealing & Boltzman distributions, SA Parameters, SA Algorithms, Convergence properties, Stochastic tunnelling

Diiferential Evolution: Introduction, Diiferential Evolution, Variants, Choice of parameters, Convergence Analysis, Genetic Algorithm

Unit III: Particle Swarm Optimization

PSO Algorithm, Accelerated PSO, Implementation, Convergence Analysis, Binary PSO Ant Colony Optimization: Algorithm, Implementation and convergence analysis Genetic Algorithm: Algorithm, Implementation and convergence analysis

Unit IV: Nature Algorithms – I

Firefly Algorithm: Analysis, Implementation, Variants of Firefly algorithm, Applications, Why the Firefly is efficient Cuckoo Search: Cuckoo Breeding behavior, levy flights, cuckoo search, implementation, variants of cuckoo search Bat Algorithm: Analysis, Implementation, Binary BAT algorithm, Applications, Why the Bat is efficient

Unit V: Nature Algorithms – II

Grey-Wolf Algorithm: Analysis, Implementation, Variants of Grey-Wolf algorithm, Applications, Why the Grey-Wolf is efficient Whale algorithm: Analysis, Implementation, Variants of Whale algorithm, Applications, Why the Whale is efficient

Course Outcomes

CO1: Define the basic concepts of Nature Inspired algorithms and analyse the performance of algorithms.

CO2: Explain the characteristics of combinatorial problems and relevant bio-inspired algorithms to be applied on it.

CO3: Analyse the working methodology of bio-inspired algorithms.

CO4: Ability to apply nature inspired algorithms to solve engineering optimization problems.

Textbooks:

1. Nature-Inspired Optimization Algorithms, Author: Xin-She Yang, Elsevier
2. Nature Inspired Algorithms and Their Applications, Wiley

Course Code	: CSL DE315
Course Title	: Cloud Computing
L-T-P/S=Credits	: 3-1-0 =4
Course Category	: Departmental Elective course
Pre-requisite Courses (if any)	:
Equal Course Code (if any)	:
Equivalent Course Code (if any)	:

Detailed Syllabus

Unit I: Cloud Computing Fundamental: Cloud Computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications.

Unit II: Cloud Applications: Technologies and the processes required when deploying web services; Deploying a web service from inside and outside a cloud architecture, advantages and disadvantages

Unit III: Cloud Services Management: Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment; Cloud Economics : Cloud Computing infrastructures available for implementing cloud based services. Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google, Salesforce.com, Ubuntu and Redhat)

Unit IV: Application Development: Service creation environments to develop cloud based applications. Development environments for service development; Amazon, Azure, Google App.

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
Text Books		
1	Gautam Shroff, Enterprise Cloud Computing Technology Architecture Applications [ISBN: 978-0521137355]	
2	Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach [ISBN: 0071626948]	
3	Dimitris N. Chorafas, Cloud Computing Strategies [ISBN: 1439834539]	

Course Outcome

Sr	Course Outcome	CO
1	Understand the architecture and different types of clouds	CO1
2	Case studies of different cloud servers	CO2
3	Understanding popular cloud platforms and creating virtual machines	CO3

- Introduction to Linear Regression Analysis, by Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining
- Introduction to Regression Analysis, M. Golberg and H.A Cho
- Applied Regression Analysis, Norman R. Draper and Harry Smith

REGRESSION THEORY & ANALYSIS LAB

Credit Units: 0-0-1

Course Contents:

Unit 1: Simple linear regression: Estimation of the Parameters, Hypothesis Testing on the Slope and Intercept, Interval Estimation in Simple Linear Regression, Prediction of New Observations, Coefficient of Determination through case studies Multiple regression: Estimation of Parameters, Hypothesis Testing, Confidence Intervals, Prediction through case studies

Unit 2: Model Adequacy testing: Residual Analysis, PRESS statistic, Lack of Fit through case studies

Unit 3: Multicollinearity: Sources, Effects, Diagnostics, Methods of dealing with Multicollinearity through case studies

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding regression analysis for predictive model development	CO1
2	To be able to handle linear and multiple regression	CO2
3	Identification of patterns in Data	CO3
4	Establishment of relationship between variables	CO4

Text & References:

- Introduction to Linear Regression Analysis, by Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining
- Introduction to Regression Analysis, M. Golberg and H.A Cho
- Applied Regression Analysis, Norman R. Draper and Harry Smith

BIG DATA TOOLS & TECHNOLOGIES-II

Credit Units:2-0-2

Course contents:

Unit 1: Introduction to Apache Spark : Introduction to Apache Spark, Features of Apache Spark, Apache Spark Stack, Introduction to RDD's, RDD's Transformation, What is good and Bad in Map Reduce , Why to use Apache Spark Spark: A Hadoop Replacement? : Java, Scala, or Python? ,

Scala, Packages, Data Types, Classes, Calling Functions, Operators, Control Structures, A Quick Intro to Spark: Starting the shell, Data Sources, Testing Spark, Spark Monitor, Comparing Hadoop Map Reduce to Spark, Writing Standalone program with Spark

Unit 2: Spark SQL, Basic Concepts, Using Spark SQL with RDDs, Spark Streaming: Basic Concepts, Creating Your First Stream with Scala, Creating Your First Stream with Java

Unit 3: Fundamental of Azure databricks: Control plane and data plane, Workspace (assets, objects), Build end to end pipeline (Create cluster, exploring source data, data ingestion, data preparation, Query, creating and running databrick job), Spark integration

Course Outcome:

S.N.	Course Outcome	CO
1	Establishment of fundamentals for big data technologies	CO1
2	Understanding use of distributing computing in big data	CO2
3	Apply and preparation of data processing workflow	CO3
4	Application to real-world data and analysis	CO4

Text & References:

- Spark in Action, Marko Bonaci, Peter Zecevic
- Spark Cookbook, Rishi Yadav
- Machine Learning for Big Data , Jason Bell
- Spark : The Definitive Guide, Matei Zaharia, Bill Chambers
- Azure Databricks Cookbook: Accelerate and scale real-time analytics solutions using the Apache Spark-based analytics service, by Phani Raj, Vinod Jaiswal, Packt Publishing Limited, ISBN: 978-1789809718

TIME SERIES

Credit Units:2-0-2

Course Contents: Introduction to time series

Unit 1: Autoregressive-moving average models ARIMA: Moving average models MA(q). Condition of invertability. Autoregressive models AR(p). Yull-Worker). Yull-Worker equations. Stationarity conditions. Autoregressive-moving average models ARMA (p,q).

Unit 2: Coefficient estimation in ARIMA processes: Coefficients estimation in autoregressive models. Coefficient estimation in ARMA (p) processes. Quality of adjustment of time series models. AIC information criterion. BIC information criterion. "Portmonto" statistics.

Unit 3: Forecasting in the framework of Box-Jenkins model Forecasting, trend and seasonality in Box-Jenkins model. Non-stationary time series, Non-stationary time series. Time series with non-stationary variance. Non-stationary mean. ARIMA (p,d,q) models. The use of Box-Jenkins methodology to determination of order of integration.

strategy presentation. Save graphs in various formats. Discuss different ways to combine multiple figures. Discuss margin and graph size.

Unit 2: Introduction to Tableau: Creating Visual Analytics with Tableau Desktop, Connecting to your data, Building your first visualization, Creating Calculations to enhance your data, using maps to improve insight, developing an Ad Hoc Analysis Environment, Tips Tricks and Time Savers, Bringing it all together with dashboards. Installing Tableau Server, Using Tableau server to facilitate fact based team collaboration, Automating Server with Tableau's command line tools, Use case for rapid fire visual analytics, other Tools. Explore various case studies to visualize the data.

Unit 3: Introduction to PowerBI: Architecture, Data Transformation, DAX, Power BI Service, Data Visualization, Power BI Reports, Connectivity Modes

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding principle and objective of data visualization	CO1
2	Apply techniques such as data extraction, cleaning and transformation	CO2
3	To be able to create interactive dashboards using Tableau and PowerBI	CO3
4	Integration of real time data	CO4

Text & References:

- Tableau your data, Daniel G Murray
- Streaming Data: Understanding the Real-Time Pipeline, Andrew G. Psaltis, Manning Publications, 978-1617296529
- Power BI for the Excel Analyst (1st Edition), Wyn Hopkins, Packt Publishing, 2024

DATA VISUALIZATION LAB

Credit Units: 3-0-1

Course contents:

Unit 1: Drawing graphs such as scatterplot, stripchart, histogram, boxplot, violoin chart, bar chart, dot plot, line graph, line plot, multiplot, stacked bar chart, pie diagram, venn diagram, pair plot. Explore 3d chart, motion chart, interactive charts. Discuss selecting appropriate chart for strategy presentation. Save graphs in various formats. Discuss different ways to combine multiple figures. Discuss margin and graph size.

Unit 2: Introduction to Tableau: Creating Visual Analytics with Tableau Desktop, Connecting to your data, Building your first visualization, Creating Calculations to enhance your data, using maps to improve insight, developing an Ad Hoc Analysis Environment, Tips Tricks and Time Savers, Bringing it all together with dashboards. Installing Tableau Server, Using Tableau server to facilitate fact based team collaboration, Automating Server with Tableau's command line tools, Use case for rapid fire visual analytics, other Tools. Explore various case studies to visualize the data.

Unit 3: Introduction to PowerBI: Architecture, Data Transformation, DAX, Power BI Service, Data Visualization, Power BI Reports, Connectivity Modes, Case studies

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding principle and objective of data visualization	CO1
2	Apply techniques such as data extraction, cleaning and transformation	CO2
3	To be able to create interactive dashboards using Tableau and PowerBI	CO3
4	Integration of real time data	CO4

Text & References:

- Tableau your data. Daniel G Murray
- Streaming Data: Understanding the Real-Time Pipeline, Andrew G. Psaltis, Manning Publications, 978-1617296529
- Power BI for the Excel Analyst (1st Edition), Wyn Hopkins, Packt Publishing, 2024

REGRESSION THEORY & ANALYSIS

Credit Units: 3-0-0

Course Contents:

Unit 1: Simple linear regression: Estimation of the Parameters, Hypothesis Testing on the Slope and Intercept, Interval Estimation in Simple Linear Regression, Prediction of New Observations, Coefficient of Determination, Multiple regression: Estimation of Parameters, Hypothesis Testing, Confidence Intervals, Prediction, Model Adequacy testing: Residual Analysis, PRESS statistic, Lack of Fit

Unit 2: Transformations: Variance stabilizing transformations, Transformations to linearize the model, Methods to select a transformation, weighted least squares, Regression and random effect, Multicollinearity: Sources, Effects, Diagnostics, Methods of dealing with Multicollinearity

Unit 3: Validation of regression models: Techniques for validation, Nonlinear least squares, transformations, Parameter estimation, Logistic and Poisson regression

Course Outcome:

S.N.	Course Outcome	CO
1	Understanding regression analysis for predictive model development	CO1
2	To be able to handle linear and multiple regression	CO2
3	Identification of patterns in Data	CO3
4	Establishment of relationship between variables	CO4

Text & References:

(Approved Under Section 2(f) and 12(B) of UGC act of 1956)

विज्ञानं ब्रह्म

Shri Mata Vaishno Devi University

School of Computer Science and Engineering

Faculty of Engineering, SMVDU

Kakryal, Katra 182320

Syllabus - Second Semester

MACHINE LEARNING

Credit Units: 3-0-1

Course Contents:

Unit 1: An Introduction to Machine Learning: What is ML, Types of ML, Applications used for ML, AI vs ML, Essential for ML and AI. Techniques of Machine Learning: Introduction to Supervised, unsupervised, semi-supervised, and reinforced machine learning techniques.

Unit 2: Unsupervised learning: Basic concepts to calculate distances: Concepts to calculate distances: euclidean distance, Manhattan distance, L1 and L2-norm, Minikowski distance etc., Discuss theory and concepts behind unsupervised learning, Clustering: Finding grouping of data. Hierarchical clustering, k-means and K-medoid clustering algorithm, Dimension Reduction: PCA, t-SNE.

Unit 3: Supervised learning: Fundamentals of Supervised machine learning: Components of supervised learning model: Data, Model: (Classification and regression), Training, Validation, Evaluating, Inference and model's complexity: over and underfitting, Binary Classification, Logistic Regression (Cost Function, regularization, etc), KNN, Naive Bayes decision, SVM, Tree based methods (Decision tree and Random Forest), Ensemble based classifiers (Bagging, Boosting, Stacking and cascading)

Unit 4: Reinforcement learning: Key concepts: Agent, Environment, State, Action, Reward, applications, advantages and disadvantages

Course Outcome:

S.N.	Course Outcome	CO
1	Establishment of fundamental concept of machine learning	CO1
2	Understanding basic concept of supervised and unsupervised learning and algorithms	CO2
3	Apply clustering algorithm to find patterns in the data	CO3
4	Understand and apply machine learning algorithms	CO4
5	Practical implementation of using tools in real world data	CO5

Text & References:

- Machine Learning by Tom M. Mitchell
- Introduction to Machine Learning, Ethem Alpaydın
- Pattern Recognition and Machine Learning by Christopher M. Bishop (Author)
- Machine Learning Yearning by Andrew NG
- The Elements of Statistical Learning by Trevor Hastie , Robert Tibshirani , Jerome Friedman

MACHINE LEARNING LAB

Credit Units: 0-0-1

Course Contents:

Unit 1: Introduction: Understanding classification and regression problem. Splitting the data into Training and test data, Understanding Overfitting and complexity with case studies,

Unit 2: Unsupervised learning: Finding grouping of data: Hierarchical clustering, k-means and K-medoid clustering algorithm, dimensionality reduction through case studies

Unit 3: Supervised learning: Working with different models: Binary Classification, Logistic Regression (Cost Function, regularization, etc), KNN, Naive Bayes decision, SVM, Tree based methods (Decision tree and Random Forest), Ensemble based classifiers (Bagging, Boosting, Stacking and cascading)

Unit 4: Reinforcement learning: Solve a case study on real world data and apply reinforcement learning concepts.

Course Outcome:

S.N.	Course Outcome	CO
1	Establishment of fundamental concept of machine learning	CO1
2	Understanding basic concept of supervised and unsupervised learning and algorithms	CO2
3	Apply clustering algorithm to find patterns in the data	CO3
4	Understand and apply machine learning algorithms	CO4
5	Practical implementation of using tools in real world data	CO5

Text & References:

- Programming Collective Intelligence by Toby Segaran
- Machine Learning for Hackers by Drew Conway and John Myles
- Machine Learning by Tom M. Mitchell
- Pattern Recognition and Machine Learning by Christopher M. Bishop (Author)
- Machine Learning Yearning by Andrew NG
- The Elements of Statistical Learning by Trevor Hastie, Robert Tibshirani , Jerome Friedman

DATA VISUALIZATION

Credit Units: 3-0-0

Course contents:

Unit 1: Introduction to data visualization: Introduction to data visualization. Explore and manipulate all graphical parameter. Drawing graphs such as scatterplot, stripchart, histogram, boxplot, violoin chart, bar chart, dot plot, line graph, line plot, multiplot, stacked bar chart, pie diagram, venn diagram, pair plot. Explore 3d chart, motion chart, interactive charts. Discuss selecting appropriate chart for